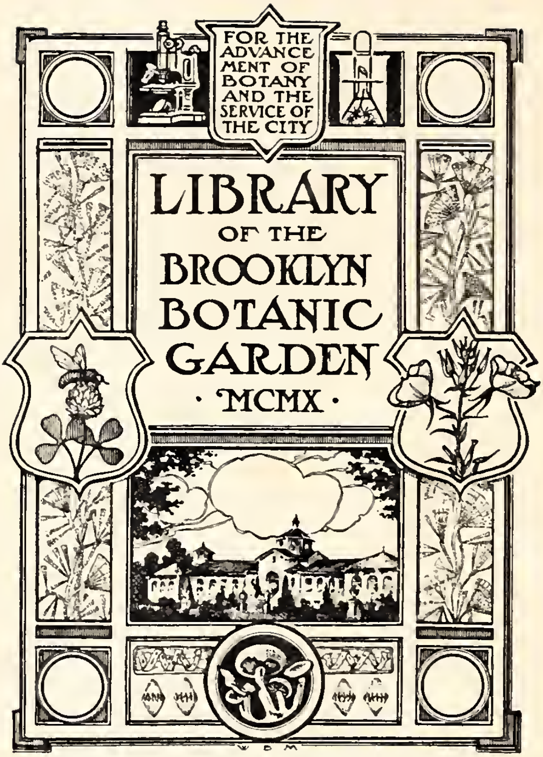

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BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES VI BROOKLYN, N. Y., APRIL 3, 1918 NO. 1

THE SMALL VEGETABLE GARDEN*

The Site.—When selecting the position for the vegetable garden (if there is any choice) one should be chosen that is open to air and sunshine, and sheltered from north and northwest winds; at the same time bearing in mind the fact that without good soil of fair depth (eight to twelve inches) large crops cannot be expected.

The Soil.—The soil is of primary consideration in the successful cultivation of vegetables, and thorough preparation is essential for the best results.

If time and labor are available, it will pay to stir up and pulverize the ground to a depth of eighteen inches or two feet, an operation known as trenching, or double-digging. It is carried out by first opening a trench at one end two feet wide and one foot deep and carrying the soil so obtained to the other end of the plot that is to be trenched. The bottom of the trench is then dug up with a spading fork and all clods thoroughly pulverized. A layer of well decayed stable manure three inches thick should then be placed in the trench. Continue the work by opening up another trench two feet wide and one foot deep, using the soil so obtained to fill up the first trench. Dig the bottom of the second trench, apply manure, and continue operations until the end of the plot is reached, when the soil taken from the first trench will be available for filling the last made trench.

If for any reason it is not possible to trench the plot, the next best thing is to cover the surface of the ground with well decayed manure three inches deep and then spade it in, burying it as deeply as possible.

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*This LEAFLET is largely a reprint of No. 4, Series V, 1917.

In the city it is often difficult or impossible to obtain well decayed manure. In this case, if the soil is already in fair physical condition, with neither sand or clay predominating, a complete concentrated fertilizer, obtainable from most seedsmen, should be applied according to directions supplied with the fertilizer—usually about 25 pounds to a plot 20x40 feet. This should contain, approximately, nitrogen 5%, phosphoric acid 8%, potash 5%. Supposing your soil is very sandy or clayey, it will be necessary to apply vegetable matter of some kind to improve its physical condition. This can be accomplished by purchasing one of the many brands of prepared humus that are on the market and applying a layer about two inches thick, then mixing it thoroughly with the soil. Many soils, especially those in city back yards, are acid, and are benefited by the application of lime. This may be applied in the form of ground limestone, preferably in the fall, scattering it on the surface of the freshly turned soil and thoroughly raking it in. Use about 40 pounds to a plot 20x40 feet. The desirability or otherwise of liming may be determined by pressing blue litmus paper on a handful of moist soil; if the litmus turns red it indicates acidity and the need of lime.

Planting.—The seed should be sown in drills of suitable depth made with a draw hoe or the edge of a rake, first making the soil as fine as possible. A line should always be stretched as a guide when making the drills, as this insures a straight row and subsequently greater ease in cultivation. Place the seed evenly in the drills, cover with fine soil, and firm with the back of a hoe or the foot.

Cultivation.—When the young plants appear, the soil around them must be hoed or scratched in some way to break the surface crust. This allows air circulation through the soil, keeps down weeds, and provides a soil blanket, or dust mulch, which assists in the conservation of moisture. If the weather permits, the surface should be cultivated in this way every week or ten days. It is important to stir the surface of the soil as soon after a rain as it is possible to work without the earth sticking to the hoe, in order to prevent undue evaporation of water.

The Plan.—The rows, when possible, should run north and south. If this is not possibe, the low growing vegetables should be placed at the south end of the plot, so that they will not be shaded by the taller growing kinds. Perennial vegetables, such as Rhubarb, Asparagus, and Artichoke, should be placed together at one end of the plot, so that they are not in the way when digging or plowing the ground for the next season's work. Crops which are to be followed by other crops later in the season should be grouped together as far as possible, as this facilitates the work and prevents disturbance of the more permanent plantings. The accompanying plan may provide helpful suggestions. The quantities and kinds of vegetables grown must, of course, be determined by individual preference:

(North) 20 feet wide (South)

2 ft.	Corn (early)	followed by Peas	
3 ft.	Corn (main crop)		
3 ft.	Lettuce	followed by Tomato	
3 ft.	Spinach (spring)	followed by ½ row Egg-plant and ½ row Pepper	
3 ft.	Potatoes		
3 ft.	Potatoes		
3 ft.	Peas (early)	followed by Cauliflower (fall)	
3 ft.	Peas (early)	followed by Cabbage (late)	
3 ft.	Early Cabbage	followed by Celery	
1 ft. 6 in.	Bush Beans	followed by Turnips	
1 ft. 6 in.	Bush Beans	followed by Beets	
1 ft. 6 in.	Beets (early)	followed by Bush Beans	
1 ft. 6 in.	Onion (sets)	followed by Beets	
1 ft.	Carrots (early)	followed by Fall Spinach	
1 ft.	Onion (main crop)		
1 ft. 6 in.	Swiss Chard		
3 ft.	Rhubarb 3 plants 3 ft. apart	Parsnip ½ row Parsnip ½ row	Sown with Radishes
1 ft. 6 in.			

40 feet long

Note.—Two rows of *Spinach*, and two rows of *Lettuce* may be grown in the space to be occupied later by *Egg-plant*, *Pepper*, and *Tomato*. Similarly two rows of *Onion sets* may occupy the ground to be used later for growing *Beets*. *Lettuce* may be sown directly in the drill where the plants are to mature, or, it may be sown in a seed-bed or shallow box and the seedlings transplanted to their permanent quarters when they are two or three inches high. *Cabbage* or *Cauliflower* are best sown in seed-bed and transplanted later. Unless one has a greenhouse or other facilities for raising tender seedlings, it is better to obtain plants of *Tomato*, *Egg-plant*, and *Pepper* from a seedsman at planting time.

Usually there is not much room in the small garden for such crops as *Cucumber*, *Melon*, *Squash*, etc. When a rich soil, in a sunny position, near a fence, is available, however, they may sometimes be grown to advantage by training them on the fence, thus economizing space.

Time to Plant, Depth to Plant, Distance between the Rows and in the Rows, and Quantity of Seed Required for a 100 ft. Row

Vegetables	*Time to plant*	*Depth*	*Distance between rows*	*Distance in the rows*	*Quantity*
Bean (pole)	May 20 to June 20	2 in.	4 ft.	in hills 4 ft. apart, about 3 seeds to a hill	½ pint
Bean (lima)	May 20 to June 20	2 in.	4 ft.		
Bean (dwarf)	May 10 to Aug.	2 in.	1 ft. 6 in.	3 in.	1 pint
Beet	April to Aug.	1½ in.	1 ft. 6 in.	4 in.	2 oz.
Cabbage (early)	Feb. indoors; plants set out in Mar.		3 ft.	2 ft.	1 oz. will produce 2000 plants
Cabbage (late)	May, indoors; plants set out in July		3 ft.		
Carrot	April to July	1 in.	1 ft	3 in.	1 oz.
Cauliflower (early)	Feb. indoors; plants set out in Mar.		3 ft.	2 ft.	1 oz. will produce 2000 plants
Cauliflower (late)	May, indoors; plants set out in July		3 ft.		
Celery	Mar. indoors; plants set out in early July.		3 ft.	9 in. to 1 ft.	1 oz., about 3000 plants
Corn	May 10 to July 10	2 in.	3 ft.	2 ft.	½ pint
Egg-plant	Mar. indoors; plants set out in late May or early June		3 ft.	3 ft.	1 oz. will produce 600 plants
Lettuce	April to Aug.	½ in.	1 ft.	9 in. to 1 ft.	½ oz.
Onion (seed)	April to May	1 in.	1 ft.	4 in.	1 oz.
Onion (sets)	Mar. 15 to May 15	2 in.	1 ft.	2 in.	
Parsley	April	½ in.	1 ft.	6 to 8 in.	¼ oz.
Parsnip	April	1 in.	1 ft. 6 in.	6 in.	½ oz.
Peas (dwarf)	May 15 to June 15 and Aug. 1 to 20	2 in.	2 to 3 ft.	2 in.	1 quart
Peas (tall)	Mar. 15 to June 15 and Aug. 1 to 20	2 in.	4 to 6 ft.	3 in.	1 quart
Peppers	Mar. indoors; plants set out in late May or early June		3 ft.	2 in.	small package
Potatoes	April 15 to June	4 to 6 in.	3 ft.	12 to 18 in.	½ peck
Radish	Mar. to Sept.	½ in.	1 ft.	2 in.	1 oz.
Spinach	Mar. and Sept.	1 in.	1 ft. 6 in.	4 in.	1 oz.
Swiss Chard	April	1 in.	1 ft. 6 in.	6 in.	1 oz.
Tomato	Mar. indoors; plants set out in late May or early June		3 ft.	3 ft.	1 oz. will produce over 1000 plants
Turnip	April and Sept.	½ in.	1 ft. 6 in.	6 in.	½ oz.

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BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES VI BROOKLYN, N. Y., APRIL 17, 1918 NO. 2

ENVIRONMENT, VARIATION AND THE LAWS OF HEREDITY

> "The organic world as a whole is a perpetual flux of changing types."—*Francis Galton.*

Infinite, endless variety is the most striking fact about the world in which we live. As though from a huge magic box, an Aladdin's cave, so to speak, new types of plant and animal life constantly issue forth. You see them in your gardens as vegetable, fruit, or floral novelties, or at the flower shows as new carnations, roses, or orchids. You see them in the plant-breeders' gardens, at the trial grounds of the great seed-houses, in the breeding pens of stock-raisers, or at the fanciers' shops. And last you meet them on the street as friends, especially if you be a citizen of one of those great pioneer countries such as the United States, Argentina, or Australia, where the shackles of tradition are still mere threads, and the "melting pot" accepts almost all "comers." No corner, however minute and obscure, of earth's vast stretches of sea and land lacks in diversity of animate form or color to those with the seeing eye. And this is as true of the vast deserts and the tiniest bits of pond-mud as it is of the verdure-clad tropical river valleys of Brazil or Central Africa, where life, even to the most superficial observers, appears kaleidoscopic.

So seldom is one of nature's forms duplicated, that even when an approach is made to it, as in the case of identical twins and the so-called "doubles" in man, the greatest wonderment is excited. Our neighbors and acquaintances are alike only in a few so-called fundamental characters. We have no difficulty, as a rule, in distinguishing them, even at a distance, or often without seeing them. Many have a peculiar gait, others have easily distinguishable voices. Some are short, others tall, with all degrees of intermediates between. Their eyes are brown, hazel, gray, blue, or pink, and a score of distinct intermediate shades too slight or too numerous generally to describe by name. Their hair comprises all degrees of diversity in form and color, from that which hangs in golden ringlets to that of the deepest, straightest black. Their temperaments, too, vary as strikingly as their other characteristics, or perhaps even more so. Some are musical and some, like Darwin, are unable to distinguish between tunes. Some are methodical, others are erratic. Even those characters which we commonly are prone to think are absolutely unvariable, such as the number of fingers or toes, occasionally exhibit variation. In fact there are said to be whole families, and in one case a small tribe, with more than the normal number of fingers and toes. Close relationship, as among the members of the same family, does not eliminate this diversity of character. How many times are parents and relatives driven to the most wild speculations to account for differences between brothers, between sisters, or between children and parents. Some characteristics we ascribe to heredity, others to environment, but in many cases neither environment nor heredity seem to explain the appearance of strange characters.

In the plant world, as in human beings, exact likenesses as seen by the eye of the specialist are rare. And this is true, even when plants are of the same variety, coming from seed produced by many generations of inbreeding. But what is still more striking is the diversity among plants of varieties propagated by cuttings, budding, grafting, or by offshoots—plants that are only isolated parts of the same plant—as, for example, the Boston fern and its fifty or more well-marked varieties, our fruit trees and berry bushes, and many of our house and bedding plants. Nectarines are found on peach trees, and white-flowered or light-colored forms of chrysanthemums and azaleas blossom out on plants largely covered with darker colored flowers. You have no trouble in distinguishing your own house plants—your own pots of geraniums, aspidistras, crotons, and ferns from those of your neighbor, even though his be of exactly the same kind. Yours show better care or perhaps worse. Your geraniums have had twenty blooms in one month, his only two in the same length of time. Detailed observations have taught us that even the leaves, flowers, and branches of the same plant, as well as the plant individuals themselves, are as unlike each other in many cases as are our friends. Examine the leaves of a mulberry tree, a Persian lilac bush, or those of a fern-leaved beech, and see for yourself the numerous forms they take on even the same branch. Compare a dozen radishes of the same variety pulled at random from your own garden, or a dozen strawberries picked from the same plant, note their differences, and be convinced of the commonness of intra-varietal variation.

The navel oranges of the west all come from parts of one original tree, as do also the Baldwin apples of the east. The original tree which first gave rise to these navels was found near Bahia, Brazil, the forepart of the last century. Though all the thousands of naval orange trees are parts of this one tree, propagated by budding, every one knows that the fruit of these numerous trees vary in grade and kind—as to form and coloring, sweetness and sourness, thickness of rind, size, and in productiveness per tree. Those grown in Florida (for they were once tried out there) were sweeter than the California product. In those from Arizona, the skin is at least of double thickness. What is true of the orange is true of the apple varieties. The Albemarle (Newtown) Pippin from Virginia is a different apple in taste and texture from those of the same variety grown in California. Western apples of almost any variety are deeper and more highly colored than those of the same variety from the eastern states, while the apples of this latter region are on the whole better flavored. In cool elevated or mountain regions, the shape of the fruit of most varieties changes to a flatter form than those of the same variety grown in plains regions. Even the much despised Ben Davis loses some of its pumpkin-like texture and potato-like taste when grown in the region where it originated.

Cabbage grown in the tropics never heads. As is well known, most varieties of head-lettuce, head only during cool weather. Turnip-rooted radishes grown in hot weather are always pithy, but this is not true of the summer growing kinds such as Strassburg. Beets or radishes grown in too much shade produce luxuriant tops and woody, slender roots. Varieties of watermelon resistant to certain diseases in Georgia appear to lose this immunity when subjected to the same diseases on the Pacific coast. The same thing is true of disease-resistant varieties of grain—the rust-resistant wheats of Australia lost their immunity when grown in North Dakota. The flax growers of the northwestern states were threatened with the destruction of their crops by a disease called flax wilt, but fortunately some of the flax plants were immune to the disease and these were isolated and resistant varieties produced. Perhaps the most striking variations are those commonly styled "freaks"—such as pineapples with thirty crowns, two-headed turtles, five- or six-legged lambs, Siamese twins, single apple trees inherently (not grafted) producing both red and yellow or sweet and sour apples, fasciated plants from normal ancestors—the common example of which is the garden cockscomb. In a park in Beecroft, Australia, there is an especially striking example of fasciation in the Norfolk Island Pine—the specimen resembling a giant cockscomb (*Celosia*) over twenty-six feet high. Fasciation (flattened stem) is probably found in all species of plants. Another striking example of it (described in a previous leaflet on *Nicotiana*) is that of a single plant discovered near Alquiza, Cuba, in a field of Havana or Cuban tobacco, a variety normally possessing only eighteen to twenty-four commercial leaves, but the fasciated specimen had over one hundred and fifty. A type of pea with a fasciated stem has been known for over three hundred years. Many types of fasciation are inherited under all ordinary conditions, while some types may only be brought about by disease or insect damages. On the Pacific coast spraying orchards with insect poisons is a general and efficient practice, but recently, a scientist has made certain observations which seem to show that the present kinds of spray remedies may not always prove efficient, as constant spraying has served as a selective agent whereby certain insect individuals naturally immune to the spray, have been isolated and enabled to increase more rapidly because of the destruction of their non-immune brethren, just as contagious diseases among the Chinese from time to time have killed off those which lack natural immunity until now, as a race, they are practically immune to a large number of the diseases which are fatal to Europeans.

So great a place in the living world has this thing called variability that with all their best efforts, our breeders, agriculturists, and seedsmen have hard work to keep it within legitimate and desirable bounds. Varieties of vegetables and flowering plants must be carefully watched on the big seed farms to keep down the rogues or worthless variations. Stock breeders must be ever on the alert to keep their breeding animals up to the standard breed type. Grain growers, potato farmers and florists suffer from the so-called "running out" of once valuable varieties. Varieties of fruit and vegetables valuable in one locality prove worthless in another and *vice versa*. That is why our forefathers here in America had to start all over again instead of using the varieties they brought from their old home. That is why our eastern grapes are of the Concord type instead of the old world solid flesh type, such as are successfully grown in the new world only in California. That is why every section of the world, differentiated by climate or soil, needs its own made-to-order varieties of fruits, vegetables, and flowers. And in order to furnish material for making these varieties, the national Department of Agriculture has explorers and correspondents in all parts of the world on the lookout for new and strange varieties and species of vegetables, flowers, and fruits. Many of these by themselves may prove almost worthless to us, but certain characters they have may be extremely valuable when combined through crossing with the desirable characters of other varieties. For example, the all but worthless Japanese hedge orange, *Poncirus trifoliata*, has sour, undesirable small fruit, but is hardy, even on Long

Island. Crossed with the much less hardy orange, desirable varieties of fruit called citranges, hardy much further north than the orange, have been produced.

Varieties of plants and animals are very likely to develop new traits and new characters when exposed to new sets of conditions. Thus the kea parrot of New Zealand changed from a herbivorous to a carnivorous bird some years after the introduction of sheep and hence became a great pest. Marked changes of color in certain species of birds are said to be brought about by changes in the substances on which they feed. The tall trees of one country may be the dwarfs of another. The Mexican Parthenium or guayule rubber plant failed to produce as much rubber when taken away from its desert environment and cultivated. The obscure and little known insects and wild plants of one part of the world may be the scourges of another, as for example the Chinese San José scale in America, the American cactus in Australia, the Russian thistle in western America.

But on the other hand, after all that has been said concerning variability, it is still a fact that certain living organisms are so strikingly similar as regards certain characters, that we are able to group them roughly into varieties, species, genera, and families. Certain characters appear to be less variable than others, both inherently and when subjected to differences in environment and these are known as fundamental characters and are often made the basis for the groupings mentioned above. This grouping or classification, however, is in many respects artificial and must always remain more or less so—serving largely as a convenient method of keeping track of them—of pigeon-holing them, so to speak, so that we may talk about them. A striking illustration of the stability of certain characters is that exhibited by plants propagated by bulbs such as tulips and hyacinths. We are told, on the authority of Darwin, that a certain Dutch bulb-grower was repeatedly able to identify 1200 varieties of hyacinths by observations on the bulbs alone.

There are said to be over 200,000 reliable species of plants, and for the most part there is very little difficulty in identifying them by certain character descriptions. But sometimes these species are not so sharply differentiated as the descriptions in the manuals would lead one to infer, and specimens that one specialist might consider as species *A*, would be classified by an equally eminent authority as species *B*. The story is told of a certain eminent botanist to whom was sent a plant for identification, that he identified it as species *A* the first year and on receiving specimens from the same plant the second year, he classified it as species *B*, remarking in self-defense when the circumstances were explained to him, that his conception of species *A* had changed in the *interim*.

Such plants as the little shepherd's purse and the brake-fern occur in the temperate zones of both hemispheres, and are easily identified. But some species undergo radical changes in appearance as environmental conditions change, just as certain varieties of the pink-flowered hydrangea becomes blue-flowered when grown in soil containing alum, and a certain variety of primrose with red flowers has only white flowers when the temperature in which it grows is raised fifteen degrees.

Variation is so rife among the characters of some plants that even the greatest specialists on classification find great difficulties to so classify them that one of them will understand what the other is talking about. For example, the genus *Rubus*, to which our blackberries and raspberries belong, contains, so some authorities say, 1,500 species, while others classify the same material into 200 groups.

When the attempt is made to call all the individuals springing from seed of the same plant a species, variation again causes trouble. Hybridization is extremely common among all cross-fertilized plants, and the characters of two closely related species which cross are shuffled and form new combinations with each other, so that often a motley array of progeny is produced when seed is sown. Seed from botanic gardens often excellently illustrate this, but the same result will happen in nature where the species occupy the same general territory. Variation in species, as previously noted, arises also in other ways. Many new types arising in nature may be lost unless extremely favorably situated and this contributes toward keeping species stable. The same species of wild plants that apparently breed so true in nature, when brought into cultivation under the watchful eye of the gardener, in most cases become extremely variable—perhaps because the gardener is on the watch and gives the new variation a chance. At any rate, wild species under cultivation generally break up into a large number of forms so strikingly distinct from each other, that they would be given specific rank had they been found wild. Take the sweet pea, the purplish-red flowered wild ancestral species of which is native to Sicily. Occasionally white-flowered sports are found wild. The varieties of sweet peas are legion now, and many would be accorded specific rank unhesitatingly were they found wild. The same is true of the petunia, which ancestrally traces its origin back to two wild South American species. The variation that has come about in the chrysanthemum since its first domestication by man is perhaps the most marvelous of all. The supposed wild species are two, one with small white and one with small yellow flowers. The two species are very similar in other respects. While some plants have varied greatly since man has had them under observation; others, perhaps cultivated equally as long and observed just as carefully, have given rise to practically no variations. This is true

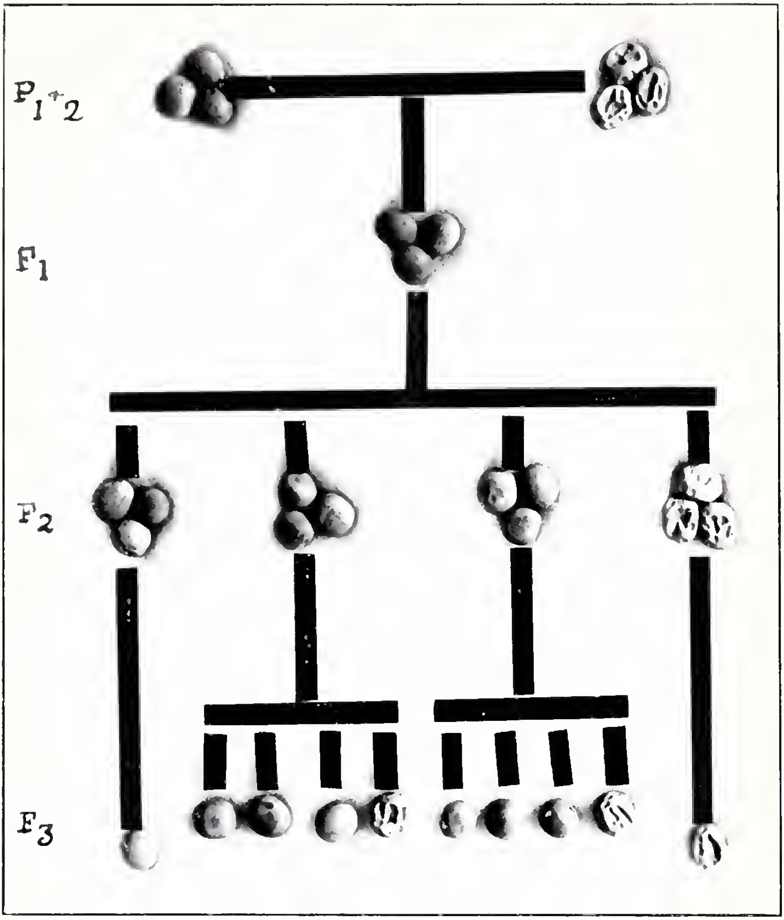


Fig. 1. Diagram showing results of crossing a variety of pea with smooth, round seeds with one breeding true to wrinkled seeds. P designates the two parent types; F_1, F_2 and F_3, the character of the successive hybrid generations.

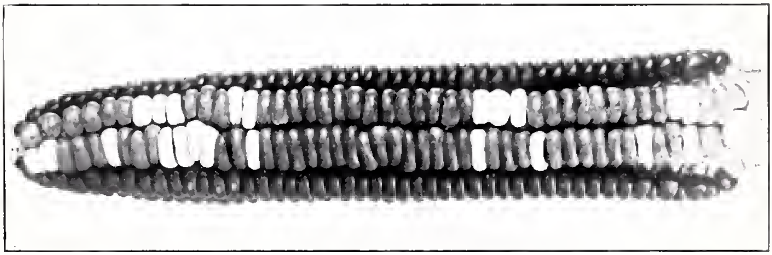


Fig. 2. An ear of corn resulting from crossing a variety having white grains with one having yellow grains, showing the F_2 ratio of three yellow to one white grain. After East and Hayes.

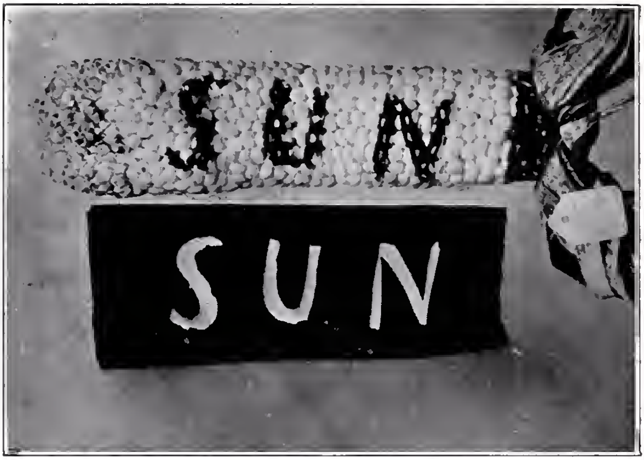


Fig. 3. An illustration of how environment may alter a character. This variety of corn has ears which remain white under normal conditions, but when allowed to mature in the sunlight by removing the husk, they color red. Enclosing an ear in black paper, with the word "sun" cut out, gave the above result, the exposed portions being red, the unexposed grains remaining white. After Emerson.

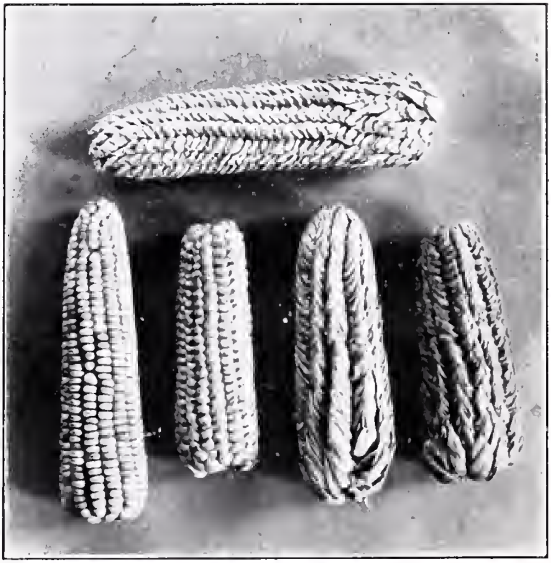
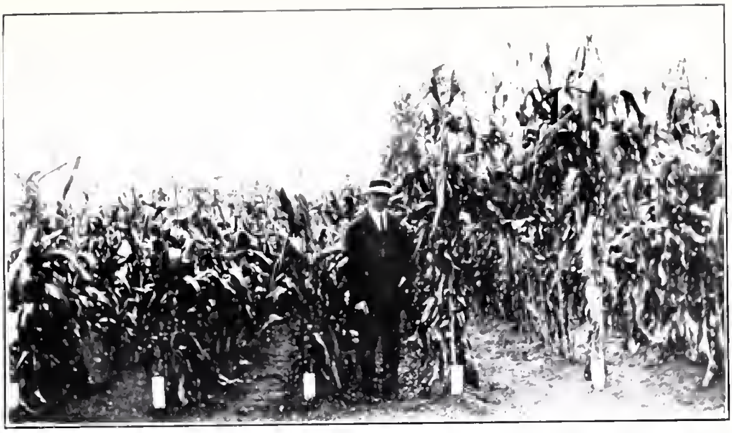
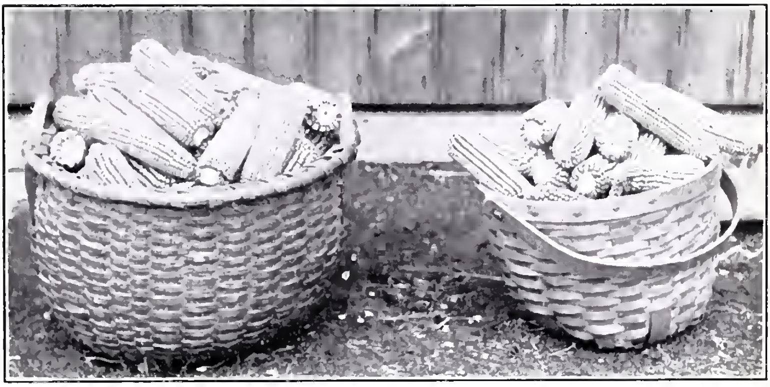


Fig. 4. Mendelian inheritance of the "podded" character in corn. The first hybrid generation above, from a cross of pod and ordinary corn; the four ears beneath representing the character of the F_2 or second hybrid generation. In pod corn, each grain is enclosed by a husk. After East and Hayes.





Figs. 5 and 6. Results of crossing two inbred strains of corn. At the left in Fig. 5 are two inbred varieties. The tall corn at the right is the result of crossing them. In Fig. 6, the basket at the right represents the average production of two inbred strains after three generations of inbreeding—61 bushels per acre. The basket at the left shows the first generation results from crossing them—101 bushels per acre. After East and Hayes.

Fig. 7. The "survival of the fittest". Breeding red raspberries to secure a hardy, non winter-killing type for the northern plains region. The staked plants represent the best selections from a large field of crosses and seedlings. After Hansen.

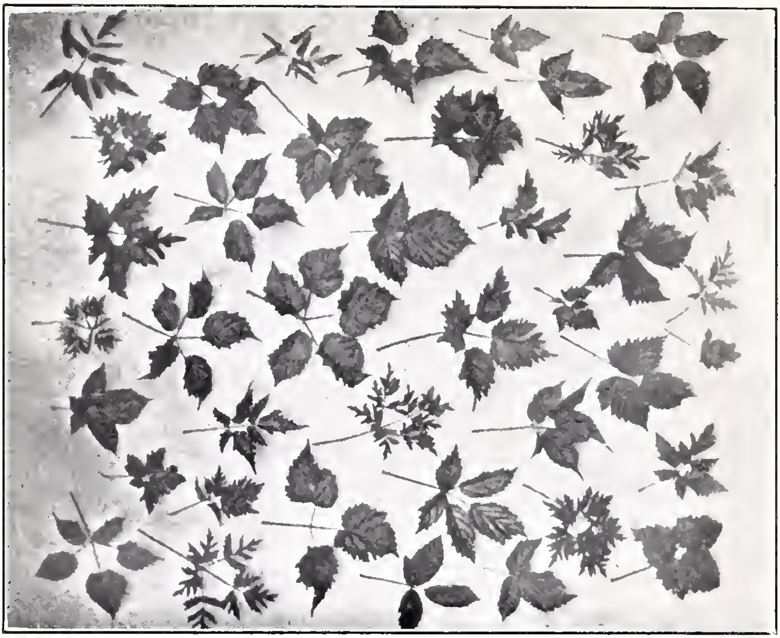


Fig. 8. The various types of leaves from progeny of a single hybrid blackberry plant. After de Vries.

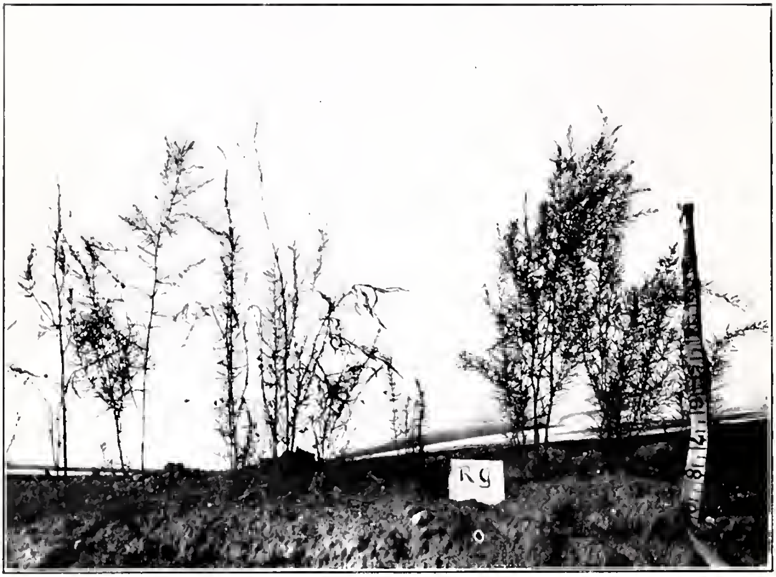


Fig. 9. Breeding disease-resistant asparagus at the U. S. Asparagus Experiment Station at Concord, Mass. On the right are disease-resistant plants, while those on the left are about half destroyed by disease. After Norton.

of the well-known lily-of-the-valley, and also was true of the various species of strawberries until they were crossed. Only after careful isolation of single plants and several generations of purification by inbreeding, does like begin to produce like, and even then the results are sometimes discouraging. By such methods, variability is reduced to a minimum, and a comparatively pure breeding strain or variety is created.

For centuries scientific men have grappled with this problem of variation, attempting to discover some law or order in all the seeming chaos that it produces. When certain characters were common to both parent and offspring they called it heredity, but often other characters appeared—characters that had been unknown to the ancestral line for generations. The breed of chickens called Blue Andalusian presented an extremely perplexing problem, as about one-fourth of the eggs always produced sooty whites, another fourth blacks, and only approximately one half gave typical Andalusians. No amount of selection and inbreeding reduced the number of these off-types. Such cases made men despair of finding any laws of heredity or variation. As soon as one was formulated, exceptions arose which shortly buried the law by their numbers. Superstition was common. Birthmark blemishes faintly resembling strawberries appeared on children due, so it was said, to mothers having seen or dreamed of strawberries preceding their birth. Hours were spent by mothers before beautiful statues and paintings, that the unborn child might be beautiful. The breeding of fine mares to scrub or to undesirable stallions for a single time was supposed later to mar the offspring of these same mares by fine stallions. Experiments by scientific men were few and far between, and largely resulted in collections of interesting but isolated facts. What was especially needed was some one who could arrange and correlate these facts into a general law. In other words, the rosetta stone had not yet been found. No one had yet discovered the key by which these facts could be interpreted. "Heredity," wrote Balzac, " is a maze in which science loses itself."

Then came the Augustinian monk, Gregor Mendel, a man with a mathematical, analytical mind. With the insight and perseverance characteristic of genius, he outlined some experiments which he believed would throw some light on the inheritance of characters and bring order out of chaos. After much experimenting, he selected peas as the material most favorable for his purpose, made certain that the varieties bred true in certain well defined characters, and proceeded with some crossing experiments between varieties differing from each other in one or more of these tested, true-breeding characters. When a plant with reddish-purple flowers was crossed with one having white flowers, the offspring were not pink, light purple, or intermediate, as one might naturally expect, but all were reddish-purple flowered and indistinguishable from the parent with colored flowers. When the seed of any one of these reddish-purple flowered plants was planted, both purple-red plants and white flowered plants were produced in the ratio of three purple-reds to one white. All the white flowered and approximately one-third of the purple-red flowered plants bred true in the next or third (F_3) hybrid generation. The other purple-red flowered plants (approximately two-thirds of all those in the second generation having purple-red flowers) produced seed which again gave the ratio of three with colored flowers to one with white flowers. From extensive experiments tried since, involving large numbers, there is every reason to believe that two-thirds of those with colored flowers from such a cross after the first generation would always produce plants with colored flowers and plants with white flowers approximating a three-to-one ratio. Other pea characters, amounting to twelve in all (six pairs), were tested by Mendel in this manner, and the results they gave agreed with those of the experiment just cited. These included such characters as the color of the seedcoat, the color and shape of the cotyledon, the height of the plants (tall or dwarf), the color of the unripe pods (green or yellow), and the nature of the stem (fasciated or normal). After satisfying himself as to the manner in which a single pair of characters is inherited, he crossed varieties which bred true to two of these differentiating characters. When tall, yellow-seeded peas were crossed with dwarf, green-seeded peas, the offspring were all uniformly tall and yellow-seeded. When seed of these were sown, four kinds of progeny were produced in approximately the following ratio: nine tall yellow-seeded, three tall green-seeded, three dwarf yellow-seeded, and one dwarf green-seeded. Out of each group a definite proportion bred true to both characters—in the first, approximately one in every nine; in each of the next two groups, one in every three, and in the last group, the dwarf green-seeded plants all bred true.

Space is too short to deal with the character of the remaining offspring in the other three groups except to say that a general law was followed. Although still more elaborate experiments were made, extending over a period of eight years in which varieties differing in three sets of characters were crossed, nothing of an exceptional nature was discovered. So from these and other results, Mendel formulated the first clear law of heredity extant—the so-called *law of segregation*. He found that the different characters in his peas appeared to be inherited as units, and that such a character as tallness could be transferred from a green-seeded variety to one with yellow seeds independently of the other characters such as green seeds with which it had hitherto been associated. The next step naturally then, was to make a general application of the law—in other words, to consider all animals and plants as being made up of many independent character materials, each of which could be separately inherited. But, as with most pioneer work, scant attention was given to the laws and discoveries which he published in 1866 in the transactions of the local scientific society of Brünn, and during the thirty-four years in which his work remained unnoticed, Mendel died, a disappointed and discouraged old man. It was said he was in the habit of comforting himself by repeating "My time will yet come."

In 1900, three European botanists—Correns, deVries and Tschermak—experimenting along similar lines, each independently rediscovered the law, and Mendel's long forgotten and neglected account was resurrected and once more brought to public notice. This time a hearing was gladly granted, a new science grew up, and general interest in plant and animal breeding spread with cyclonic rapidity. The study of heredity became a fad which reached its height in the science of eugenics. Through Mendel's work, and the encouragement derived from his discoveries, the nature of variation and heredity and their relation to environment is beginning to be understood. Variations can now be classified from the standpoint of cause, instead of only by form or by appearance. When three varieties of beans, each breeding true to white seed, are crossed with a single variety of bean breeding true to red seed-coats, and in each cross a different colored progeny is obtained (black, dark blue with white specks, brown-gray), we are not thrown back into the old time chaos. Thanks to Mendel's methods and conception, we have a clue by which we are able to see law and order in this seemingly contradictory result. And what is far more important, we are able to repeat this performance again and again with the same results.

Since 1900 many important modifications of Mendel's original conceptions have come about, as might be expected when scores of experimenters are engrossed in the experimental study of hundreds of different plant and animal forms. Important among these modifications is our conception of what constitutes a character. The vague meaning attached to this term by the older biologists is gradually being replaced by the usage of the chemists and physicists. In this sense, a character must always be looked upon as the combined result of heredity and environment. The heredity units themselves are not characters in any sense, but, in conjunction with environment, express themselves as characters. The units themselves are to be regarded as the primary elements of the "living" world, just as oxygen and sulphur represent elements of the so-called inorganic world. Another modification of Mendel's conception is that of linkage. For we find that certain characters are either partially or always inherited along with other characters, not always separately as Mendel supposed. Many of these characters in certain animals are sex-linked. In the little banana fly, over one hundred of these differential heredity units have been studied and instead of finding that each is inherited independently of all the others, the discovery has been made that they are inherited as though more or less loosely linked together in four groups. In plants similar discoveries have been made though not on as large a scale. In peas themselves, colored flowers are found to be partially linked or coupled with the materials responsible for late flowering, while the white flowers are partially associated with the materials responsible for early flowering time. One pea variety with no tendrils and having wrinkled seed, crossed with a smooth-seeded, tendrilled variety, gives smooth-seeded, tendrilled offspring in the first generation, while in the second, where four types of plants are expected in the proportion of 9ST: 3WT: 3 S non-T: 1 W non-T, approximately only two appear, the two central groups being represented by very few individuals. The two outside groups of course are the same combinations as found in the original parents of the cross, and though the two characters naturally would not be expected to be associated in any way, experimental work has shown us that they are almost completely coupled. There are numerous other modifications of Mendel's ideas, but all of these, though important, are to be regarded as superstructures built by the methods and on the foundation stones laid down by Mendel.

Through the light thrown upon the nature and inheritance of characters by Mendelism, experimenters soon came to a radically different conception regarding the rôle selection played in the creation of new varieties. Wheat, beans, and other plants, once freed from impurities by constant inbreeding, practically bred true, provided they were always subjected to the same environmental conditions. Certain varieties of wheat thus treated by the Vilmorin family of France have remained stable for forty years. Some varieties of peas are said to have bred true for a still longer period. Sugar percent in sugar beets has not been appreciably increased over that obtained during the first years when the selection for a high percentage of sugar began, although more stable varieties have been obtained. On the basis of this kind of evidence, together with that obtained from more recent experimental studies, selection is found not to to be the creative agent Darwin and most of the nineteenth century breeders and scientists supposed. Selection, so many experimenters believe, cannot alter the nature of the hereditary units, nor can it cause them to come into existence. Chance, or fortuitous variation, brought about no one knows how, seems to be the only method by which new units arise. To obtain a blue rose from a red-flowered variety, one must wait, so most scientific breeders believe, until a blue-flowered variation occurs—for selection is of no avail except as a method of isolating desired variations that are already in existence. When such variations arise in naturally inbred plants, such as peas, they generally breed true at once; but in cross-fertilized species, such as corn, purification by selection must be practiced to secure a true breeding strain.

Inasmuch as most of the higher plants and animals result from a union of two microscopic cells, and as each of these cells may carry the hereditary units which together with environment are responsible for the characters of these organisms, it follows that every sexually produced animal or plant that breeds true for several successive generations must have at least two of these units, identical in every respect, for *each of the characters* in which it breeds true. The only exceptions are those cases where a number of characters result from one kind of unit, in which case two of these units, exactly alike, may be responsible for several characters, as, for example, in the characters pink flower color, red leaf axil color, and gray seed coat color in peas.

Granting for the time being that the Mendelian method of analysis is applicable to practically all the characters of the world of living organisms,—that plants and animals are made up of independently inherited units, which, in combination with environment and with each other, express themselves as characters; and granting further that these units are unvariable and not modifiable by selection, how can we arrange and account for all the variation we see about us?

If the conceptions of Mendel and his followers hold as regards the composition of organisms, variations may only occur:—

1. When the complex of heredity units constituting the organism remains the same, and the external environment (*e.g.*, soil, climate, food) is changed.

2. When one or more of these units is added to or subtracted from the organism (through crossing), the external environment remaining unchanged.

3. When both the complex of hereditary units and the environment are altered.

4. When the environment remains the same, but the complex of hereditary units (the organism) is altered by the "addition" of a new hereditary unit, or the "subtraction" of an old one (mutation).

All four of these statements find illustration in almost every plant breeder's experimental garden. At the Brooklyn Botanic Garden, the plant material for the study of heredity is largely made up of peas, castor beans, and corn, in which many units have been isolated. Studies are also being made on variation in the Boston fern and its varieties. In Boston, at the Bussey Institution of Harvard University, the material is principally tobacco and corn; and among animals, mice, guinea pigs, rats and rabbits are undergoing investigation. At Cornell University, beans, corn, morning-glories, and cereals are being studied; while at Columbia University, students are analyzing the hereditary composition of the little banana or pomace fly, of which there are over two hundred varieties. At Cold Spring Harbor, L. I., numerous studies on various plants, animals, and man are under way, while at the University of Wisconsin, soy beans, pigeons, dogs, etc., are being investigated.

In peas, over thirty of these units have been isolated, some of which are of commercial importance, such as those for tallness and dwarfness, blunt pod, parchmented and non-parchmented pods. In tomatoes, color inheritance has been fully worked out at the New Jersey Experiment Station. An authoritative summary of the studies on color inheritance in animals,—pigs, cats, dogs, cattle, horses, guinea pigs, rats, etc.—has been appearing in *The Journal of Heredity.*

Heredity units of commercial importance have been isolated for castor beans as well as for many other plants. In corn, as many as thirty units or factors are known, while in the banana fly over one hundred have been determined. In some plants, crosses between certain varieties (not all) have given increased productivity in the first hybrid generation, and in the case of corn, walnuts, and tomatoes, the use of first generation (F_1) crossed seed is commercially important in increasing the crop. (See Figs. 5 and 6).

Among books on plant breeding and genetics, A. D. Darbishire's "Breeding and the Mendelian Discovery" is very readable to a laymen, and authoritative. Castle's "Genetics and Eugenics" will appeal to the more practically inclined. More specialized treatment is to be found in books by Professor Morgan and his co-workers.

In a former LEAFLET (Series III, Nos. 10 and 11), directions are given for carrying out plant-breeding experiments in one's own garden—a field capable of affording much pleasure and some profit.

ORLAND E. WHITE.

BROOKLYN BOTANIC GARDEN
LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

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OUR COMMON GARDEN VEGETABLES
THEIR HISTORY AND THEIR ORIGIN

When buying the day's vegetables or planting a garden to raise a year's supply, did you ever consider how man came to grow these particular plants—celery, potatoes, radishes, beets, etc., instead of hundreds of others that might possibly have been just as tasty and productive? Have you ever seen the wild ancestors of some of our most palatable vegetables? And if so, did you recognize them as such? As an explorer in search of new and valuable food possibilities, would it occur to you to "try out" the weedy wild carrot, wild parsnip and wild lettuce of the vacant lots and uncultivated fields? Do you realize how strange the vegetable marts of Europe previous to the discovery of America would have looked to you? There would have been no string beans, no lima beans, no potatoes, sweet or Irish, no corn, no pumpkins, vegetable marrows or squashes, no peppers and no tomatoes, for these are all native to America. Did you know that all the cabbage tribe, the cresses, turnips, carrots, beets, and many others now commonly grown about New York City were immigrants like ourselves, many of them having journeyed from the East Indies, Central Africa, Northern Asia and far New Zealand? And if you should talk to the men in charge of introducing new plants,—the agricultural officials of our federal and state experiment stations, and the collectors of the big seed companies—they would tell you the earth is still being ransacked for new things to eat in the vegetable line. They could tell you the vegetable ingredients of "chow main" and "chop suey," of how cheaply and efficiently the Chinese and the inhabitants of other densely populated regions live practically without the use of meat. They could tell you of giant winter radishes (40-50 lbs. in weight) from Japan, of oriental beans that produce twice the quantity per acre that ours do, of muskmelons that keep for months, and various other queer green-grocer's wares. And if you go to your local botanist, he can tell you of lamb's quarter, of wild mustard, of pokeweed and other weeds and wild plants that grow in profusion about you and go to waste every year for want of picking while you buy laboriously raised spinach—neither as fresh nor as cheap as these "weed" greens. The origin and world-wide distribution of our common vegetables is a history of famines, of exploration, of changing tastes, of dire necessity, and awakened curiosity. It is a history of a few men battling against a people's age-long habits and prejudices in order that these people might live better. It takes fifty years to introduce a new vegetable into India, writes one authority. And it is the worst thing we are up against—this prejudice against new things—remarks one of our own agricultural officials. But to return to our subject—the vegetables we usually style American are largely gifts or heirlooms from the ancient Indian civilizations of Peru and Mexico—relics of the long vanquished empires of the Aztecs and the Incas.

Corn, for example, is supposed ancestrally to have arisen somewhere in the plateau region of southern Mexico or of northern South America. When the white race first came in contact with it, the Indians had distributed it far and wide over both continents of the New World—from Argentina to southern Canada, from ocean to ocean. Vast fields of this grain were traversed by the Spaniards in their pioneer marches and explorations in what are now the states of Florida, Alabama and Mississippi. Even those Norsemen which history vaguely affirms, landed in this country about 1002 A. D., were said to have seen a wicker or log crib for corn. Columbus, writing in 1498 to his patron king and queen, speaks of passing through 18 miles of cornfields. Over 7,000,000 bushels were bought annually for the Mexican palace of the Aztec rulers. A French military expedition against the Seneca Indians in 1685, spent ten days burning what was computed to be 1,200,000 bushels of corn. As to varieties, they were as varied in texture, size of grain and ear, time of maturity and as kaleidoscopic in color as they are to-day. No "wizard" white man can claim credit for "creating" sweet sorn, flint corn, pop corn, dent corn and the various other types—for these were known and cultivated by the Indians long before his coming. In fact the first sweet corn raised by the white man was obtained from the Susquehanna Indians in 1779 and grown around Plymouth, Massachusetts. In 1854 there were only a few varieties known, perhaps not more than two. The hundred or more varieties obtained since then have largely resulted from either accidental or artificial hybridization or crossing with pop and field corn. The proper name of corn is maize, derived from the Haytian Indian word "Mahiz" applied to the same plant. Corn is an old world term for grain, especially wheat, and brings confusion when applied to maize. Wild maize is unknown and many botanists suppose it resulted from chance hybridization between a closely related plant called teosinte and some other unknown grass. Others are inclined to look upon pod maize as either the wild plant or somewhat similar to it. In many European countries ears of maize are so little known as to be objects of great curiosity. Likewise, popcorn, until very recently, was very rarely seen in Germany.

Wild potatoes of a large number of species are common in many parts of the Andean and Mexican plateaus as well as in the fog-embowered islands of the Chilean Archipelago. One wild variety flourishes as far north as southern Colorado, but this form has not contributed anything to present-day potato growing, except the "potato-bugs," for which it, together with other Solanaceous plants, long furnished a comfortable and acceptable home. Another species, *S. Commersoni,* now attracting attention in Europe, is native to dry, rocky situations in Uruguay and Argentina. *Solanum tuberosum,* as the wild form of the common potato is called, is common in Chile and perhaps in other parts of the South American west coast region, where it to-day flourishes in as many varieties, though not in as desirable ones, as there are or ever have been in cultivation. According to DeCandolle and others, the potato has been cultivated in Peru for two thousand years or more, and it was from near Quito, Ecuador, in the forepart of the sixteenth century, that the Spaniards first brought it to Spain. From there it was taken to Italy and then to Belgium and France. So far as history tells us, the North American Indians did not cultivate it nor did the highly civilized Aztecs of Mexico. So the English colonists in Virginia probably secured the potato first from Spaniards, and either from their supplies or from those found in a captured Spanish ship, Thomas Herriot of the Sir Walter Raleigh expedition introduced them into Ireland in 1585. The Irish planted them everywhere and used them as a commissary in maintaining their opposition to English rule and this gave them the now widely used English name of "Irish potatoes." Europe as a whole did not "fall in love at first sight" with the potato, and as late as 1771, only a few varieties were listed in the English catalogs. Frequent famines caused the Irish to appreciate its good qualities, while grain crop failures and attendant evils brought them into similar esteem as a field crop in Germany about 1772. The Presbyterian immigrants from Ireland introduced the potato to the New England colonists in 1718, although it is said to have been served at a Harvard dinner in 1707 as a great and rare delicacy. The Peruvians made a bread called "chunno" from potatoes, while one of the early English herbalists mentions them as a delicacy and "no common food." Another plant-lover, writing in 1640, says that in England potatoes were roasted, steeped in sack or sugar, or baked with marrow (an old country form of pumpkin) and spices, and even candied by the confectioners. In 1914 in France occurred a unique exhibition, commemorating the work of Parmentier in popularizing the potato among the French, and recalling the difficulties often experienced in changing a people's food habits. Prominent Frenchmen, as well as Englishmen, had tried various expedients, such as "society dinners," etc., to popularize the potato, but their efforts were of little avail. Parmentier's attention to the value of potatoes as food came about through noticing the soldiers dig them up and roast them over the camp fire during the terrible Seven Years' War, when food was extremely scarce. His investigations led him to devote his life toward popularizing them. He, like others, inaugurated potato feasts, the result of which made him so unpopular that he failed to be elected to a desired government office, the people fearing he would force them to live entirely on potatoes. Finally, he hit upon a successful scheme, based on the principle that "stolen sweets are sweeter." The king annually held a military review on a piece of ground near Paris, noted for its extremely poor soil. The day after the review, Parmentier planted this land to two kinds of potatoes, one which 'twas said "would grow in powdered glass." The Parisian crowd looked on in amused contempt, which later turned to stupified astonishment, when they gathered to witness the harvest. During the day when the potatoes were being dug, the immense crowd was kept back and the potatoes guarded by soldiers, but these guards were removed at night to encourage stealing. The yield was nine-fold, even under such unfavorable conditions—not counting those stolen, which no doubt must have been considerable.

In 1882, the weekly consumption of potatoes in London amounted to 500 tons, and the quantity sold in its streets between September and April through the "baked potato hawker's" cry of "Warm your hands and fill your belly for a ha' penny" was estimated at 60 tons weekly. To-day, the world's crop is over five billion bushels and they are grown in and known to almost every country on the globe. One acre has been known to yield as high as 1,200 bushels, although the average for the most favorable potato countries lies between 150-210 bushels per acre. One acre of potatoes often supplies as much food as ten acres of wheat.

As second cousins of the potato, we have tomatoes, red peppers and the egg-plant. The first of these is regarded as a form of the wild, small-fruited tomato of Peru, similar in many respects to our present-day plum and cherry tomatoes. So far as our records go, many forms of this species were introduced into America and Europe, and the tomato, as with many other cultivated plants, probably owes much of its great diversity in kinds to a large number of wild forms belonging to one variable species, the characters of which have been shuffled and combined by artificial and natural crossing. It is extremely doubtful if the ancient Peruvians appreciated the good qualities of this plant enough to extensively cultivate it. And it is certain that less than a hundred years ago, even Americans looked with suspicion upon it as the cause of various ills, such as cancer, and grew it largely for ornament instead of food. There were several types of these "love apples" as they were called in those days, all of which were comparatively small fruited (2.5 inches in diameter), except one form called "Large Red," which sometimes produced fruits over 4 inches through. These large fruits were somewhat ribbed and angular, but on the whole, fairly smooth. Then appeared a giant fruited form of this, evidently a monstrous or fasciated condition, so far as the fruit and blossom was concerned. The fruits often weighed 4 pounds, and sometimes even over 5 pounds, but they were deeply ribbed, corrugated, and almost anything but smooth. Through the efforts of various seedsmen and especially those of the pioneer scientific farmer and one time street commissioner of New York City, Colonel Waring, tomato varieties with smooth skins, solid flesh and of large size, were obtained by crossing the small, smooth, watery, seedy types with these large fruited forms. One of these was the Trophy, which is said to have been an epoch maker in commercial tomato growing. Seeds of the Trophy, first distributed in 1870, were sold for five dollars per packet of 20 seeds, single seeds commanding 25 cents each. Tomatoes of perfect shape and smoothness weighing almost a pound and a half were obtained from this variety. Tomatoes were first used commonly for food in Italy, then in France and England. They were introduced into England as early as 1596. An eighteenth century English gardener writes about them, together with egg plants, as great curiosities for the garden. An English herbalist says tomatoes were used in hot countries "to cool and quench the heat and thirst of their hot stomaches." The first tomato was commercially canned in 1847. The average yield of salable fruit for the United States is probably around 6,000 pounds per acre, but a not at all exceptional yield is 30,000 to 40,000 pounds. Over 500 varieties of tomatoes are known to the American trade at present, whereas fifty years ago there were a dozen or so.

Red peppers were as popular as a food condiment among the ancient inhabitants of the Americas as they are to-day among their descendants in Mexico and the Andean highlands in the form of Chili con carne, hot tamales and other mouth-burning food preparations. Toward the end of the sixteenth century, European physicians regarded red peppers as a cure-all for various ills, such as dropsy, colic, ague, tooth-ache, quinsy, tropical fevers, gout, paralysis, and many others—a sort of primitive "Peruna." At this period, the "dietitians" believed red peppers aided digestion, instead of the opposite as now. Thus the fashions change. According to various authorities, tropical South America, especially Brazil, was the original home of the various species or forms which through crossing and natural variation, have given us our present varieties, some thirty of which are quite common.

Though closely related botanically to the tomato, potato and pepper, the egg plant is not an American. Its original home is supposed to have been India, where a closely related wild species *Solanum insanum*, is quite common. The relationship of the egg plant to these three vegetables as well as to tobacco is exemplified by grafting all of them into one plant, the result being a single plant bearing egg plants, tomatoes, tobacco leaves, and potatoes, each after its kind—a startling curiosity perhaps, but not commercially valuable. The egg plant was cultivated in north Africa in the ninth century but was not introduced into England until 1597. In India it is often known as "brinjal" and the natives eat them in curries or roasted in red-hot ashes and mashed with salt, lime juice, onions and chillies. In France they are called "aubergines" and the white fruited varieties are preferred.

Pumpkins, vegetable marrows, and most of the summer squashes are regarded by the botanists who classify plants as forms of one species, *Cucurbita Pepo,* probably native to tropical America, though no wild forms are known with certainty. From a geneticist's standpoint it is extremely doubtful that forms with such extremely diverse characters, such as those of the field pumpkin and the Scalloped Bush or Patty Pan summer squashes, belong to the same species or trace their origin back to the same or similar wild ancestors. Both pumpkins and summer squashes, however, appear to have been grown by the Indians in their corn patches all along the Atlantic sea coast when the European colonists landed and settled this section. The island of Nantucket is said to have had a warty variety, which gave rise to our common field pumpkin. During the American Revolution, a crude form of sugar and a sweet syrup were obtained from these pumpkins and used as sugar substitutes. The first pumpkin pies were very different preparations from those of to-day. They were made by cutting a hole in the side of a pumpkin, extracting the seeds and fibrous matter, stuffing the cavity with a mixture of apples, spices, sugar and milk, then baking the whole, and this, says an old chronicler, "is commonly called pumpkin pie." Pumpkins are grown in all warm countries now, the crop yielding from 8-15 tons per acre, and being much esteemed for fall stock food, Jack o' Lanterns and Hallowe'en festivities.

Winter squashes, among which are included some types with fruits very much resembling pumpkins in both shape and color, belong to two species, *Cucurbita moschata* and *C. maxima,* both of which have not been definitely allied with wild species. Hence their native country is unknown, though the bulk of the evidence points to tropical South America, especially the west coast as the home of *C. maxima.* Some botanists believe the other species to be from southeastern Asia, but the presence of an allied wild species in Uruguay and perhaps elsewhere in America, makes this doubtful. The seeds of both these species have been found in the ancient Peruvian tombs of Ancon near Lima. Neither pumpkins nor squashes, so far as we can learn, were known or at least common in Europe before the discovery of America, but they became plentiful a century or so later. The Hubbard, Autumnal Marrow (Boston Marrow), Mammoth, and others belong to *C. maxima.* Some varieties such as Mammoth, Chilĭ, Valparaiso and others were introduced directly from Western South America, while the Hubbard, introduced in 1857, was probably brought from the West Indies. Some varieties of this species bear the largest fruits known, and these are very often called pumpkins. At country fairs, specimens are sometimes seen, weighing 200 to 300 or more pounds and of sufficient size to literally house "Peter Pumpkin Eater's Wife," provided she was a small sized woman.

The old time Winter Crookneck is supposed to be a form of *C. moschata,* and a very similar variety has been obtained from the Seminole Indians of Florida who have grown it from time immemorial, supposedly. This, if true, is another link in the chain that points to America, and not Asia, as the original home of this species, unless this species was introduced by Asian visitors previous to the white man's coming. In India, the natives grow pumpkins and squashes, as well as various gourds, over their houses.

The cucumber is undoubtedly native to India, where a wild representative, *C. Hardwickii* Royle, is still quite common. Western Asia and India have probably cultivated the cucumber for over 3,000 years, and its introduction into China took place in the second century B.C., when a Chinese ambassador returned from a mission to western Asia. In ancient times, as now, immense quantities of this vegetable, as well as various melons, were grown in the "near East"—in Syria, Persia, Russian Turkestan, and the Caucasus. The Egyptians are also supposed to have known the value of this salad vegetable, and in the trek of the Israelites through the wilderness, there were many loud complaints about their manna fare, mixed with such regretful exclaimations as "We remember the fish which we did eat freely, the cucumbers and the melons." In the ancient Hindu chronicles, married women are told to worship the cucumber that they may not lose their husbands. Under the name of sikuos, ancient Greece cultivated and partook of the cucumber, while in Rome, the emperor Tiberius so loved this fruit, that he had it grown in boxes on wheels and moved about so as to derive the full benefit of the sun. In winter, they were grown in crude hot-beds. The English were introduced to the cucumber in 1573 and owing largely to the cool climate, they grow peculiar long fruited greenhouse varieties, quite distinct in flavor from ours. The pickled little spiny gherkins are native to the West Indies and belong to a distinct species, *C. Anguria* L. In many oriental countries, young fruits of melons are used as vegetables. Thus the Hindus prepare a delightful vegetable dish from a two-thirds mature watermelon of a special variety by frying it in butter (ghi) with split gram peas (Turkish peas or garbanzos), and a curry powder made of black pepper, cinnamon, cloves, cardamons, dried cocoanut, turmeric, salt and asafoetida. This melon is also prepared by boiling well, then adding milk, pepper, salt and nutmeg. Before the advent of pumpkins and our common squashes the Europeans used various gourds, especially the dipper or calabash gourd (*Lagenaria*) as a substitute.

Beans, both dry and green shell, as well as string beans, Lima beans and Scarlet Runner beans are all natives of tropical and sub-tropical America and both the common bean (*Phaseolus vulgaris*) and the Lima (*P. lunatus*) were met with commonly by the Spaniards when they first came in contact with the Indians of Florida, Mexico and Peru. Wild forms of the large Lima bean are known from the upper Amazon River valley and its seeds have also been found in the ancient Ancon tombs of Peru. When America was discovered, historic records indicate that the common bean had been widely distributed among the Indians of both South and North America. In many of the warmer sections of these two continents, the Lima was also well known. In the southwestern desert region of the United States, a distinct species has been cultivated possibly for thousands of years, the Indian traditions indicating that the cliff dwellers and other prehistoric inhabitants, long since vanquished, first gathered it from the nearby canons and began its cultivation. Over 300,000 bushels of these teparies, as they are called, were raised and marketed in 1917, the white varieties being similar to our small pea bean or navy. Beans first came into general usage in this country during Civil War times. When the soldiers returned home, they retained their liking for them and thus a dependable market was produced. Hundreds of varieties of beans were apparently known to the Indians and now the varieties number thousands, 500 or more of which are of the bush type. This bush type seems to have appeared since the "white man's" coming to America, since the Indian varieties are believed to have been either pole or viny bush types.

The beans of the old world, previous to America's discovery, were the seeds of various legumes, especially those of *Vicia Faba,* the broad or Windsor bean, and certain species of *Dolichos.*

Sweet potatoes are not of African origin, as one might logically suppose from the intimacy that exists between them and our colored population. Most botanists credit them to tropical America, where a closely allied wild species and possibly the ancestral one, *Ipomoea fastigiata,* is quite common. Sweet potatoes, like the common potato, corn and beans are of extremely ancient cultivation in America, the Spaniards and other early explorers finding them common among the Indian tribes of southern Mexico, the West Indies, Peru, and northern South America. In fact, the name potato rightfully belongs to this sweet-tubered form of the morning-glory family, as it, and not the Irish potato, was the common potato of Elizabethan and Shakespearian times, its Spanish name "batatas" being corrupted into the English "potato." Long afterwards the common potato was called "Irish potato," in distinguishing between them. Although introduced to Europeans very soon after the discovery of America, its culture and dissemination was slow and its popularity in France was increased by the Parisian restauranteurs agreeing as a body to buy and serve it on their tables. The Empress Josephine, remarks a Frenchman, true to her Creole taste, was exceptionally fond of them and increased their popularity by ordering large quantities planted on the French Crown lands. America, however, is still said to be the largest consumer, the estimated crop for 1917 being 87,141,000 bushels, or about one-fifth of the estimated Irish potato crop for the same year. This amount, if rationed out would allow nearly a bushel to each man, woman and child in our country, but unfortunately storage difficulties are so great that it has been said that for every sweet potato eaten, three rot or are otherwise lost, hence each sweet potato consumer pays for three potatoes he never sees. In the south, certain varieties of sweet potatoes are erroneously called yams, a plant most remotely related to the morning-glory family.

Most of the vegetables so far mentioned have been American in origin, but the great bulk of the green grocer's wares, so far as diversity is concerned, are natives, like ourselves, of the old world. Of forty-four common market vegetables of New York City, thirty-five are of European, Asiatic or of African origin, while one, the common mushroom, is native to the whole northern hemisphere, though first introduced as an inviting dish by Europeans. If many of the uncommon vegetables of the semi-foreign city markets, such as garbanzos, bamboo sprouts, water chestnuts, and sprouted beans are included, the percentage of old world vegetables is still higher. Of these thirty-five or more kinds, nearly all come from Europe and Asia—a rather strange fact when one considers the luxuriance and diversity of tropical plant life.

In a large number of cases, as you have probably already surmised, these vegetables have been cultivated by man so long that the identification of their wild ancestors is somewhat in the nature of a guess, especially when reliance is placed on character comparisons. For, many of the variations among cultivated plants are so striking that with our commonly accepted notions regarding variability and heredity, it seems almost impossible that such a plant as the common wild cliff cabbage of Europe and Asia could give rise to all our cultivated forms of cabbage. Yet, if this plant is not the ancestor, what plant is? Of all the plants botanists know, it most nearly resembles what they believe that ancestor should look like. Growing on the bleak chalk cliffs of Dover or along the Medi-

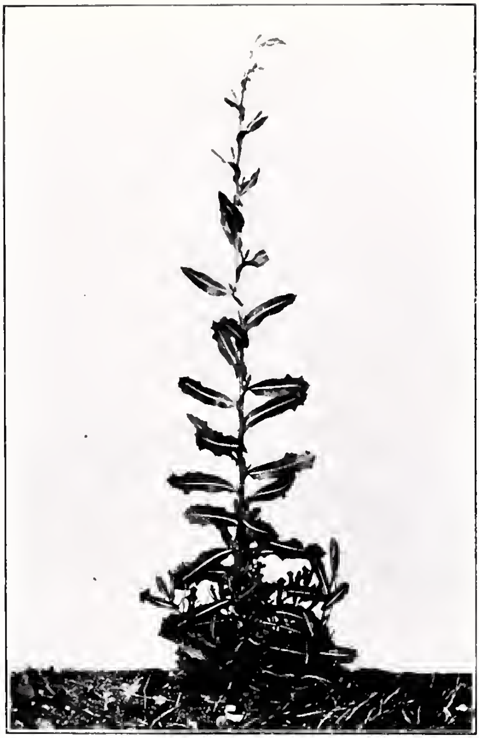


Fig. 1. A nearly mature plant of wild lettuce, *Lactuca scariola* L.

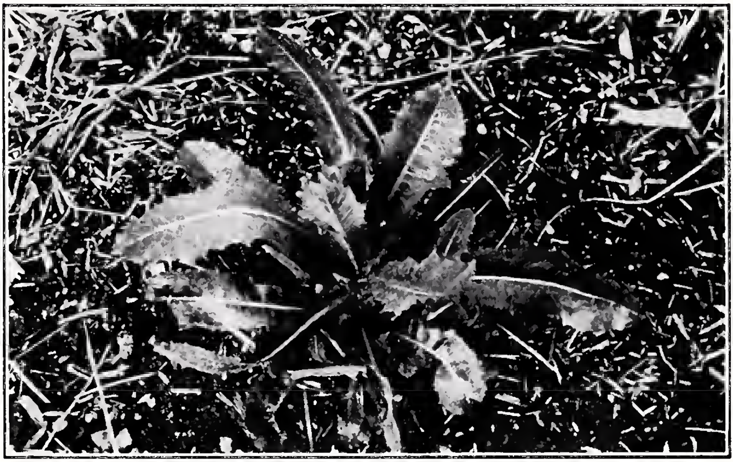


Fig. 2. Wild lettuce in the rosette stage.

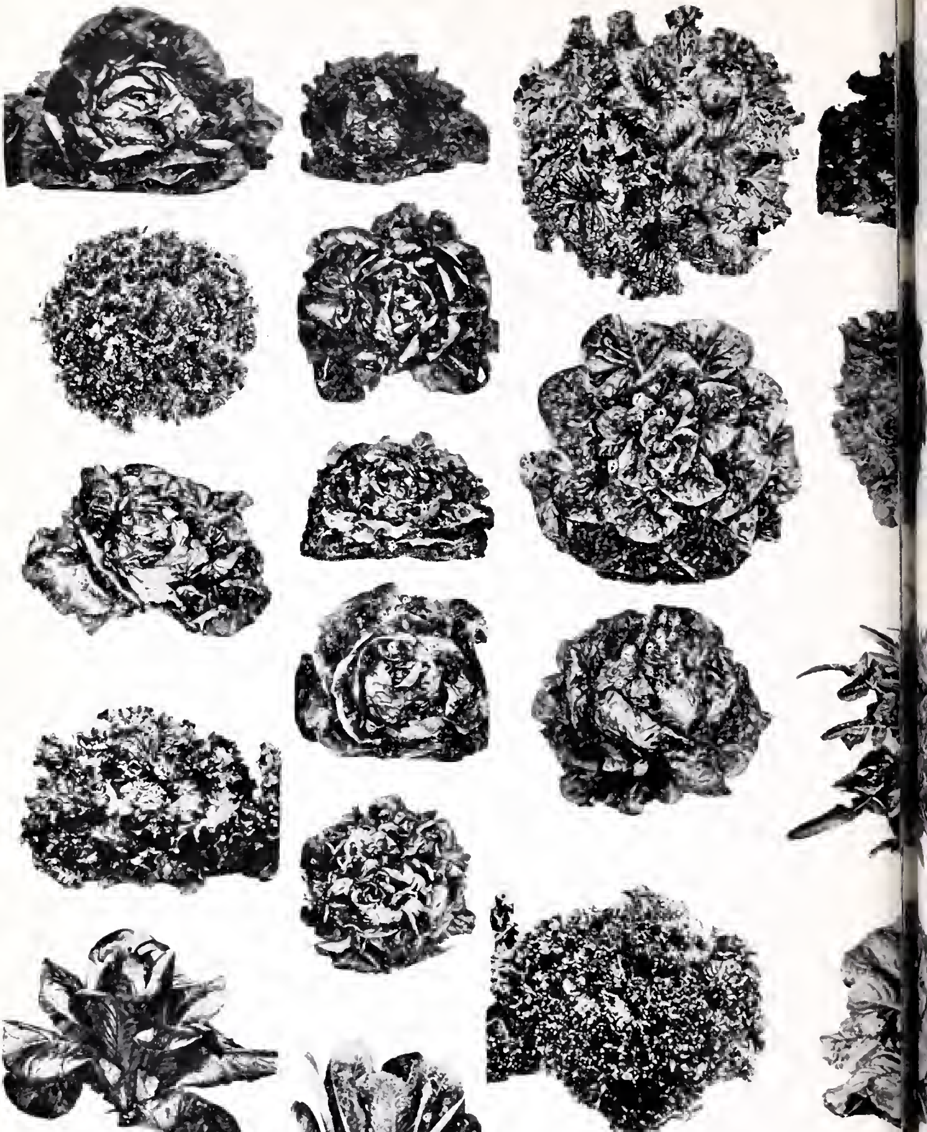
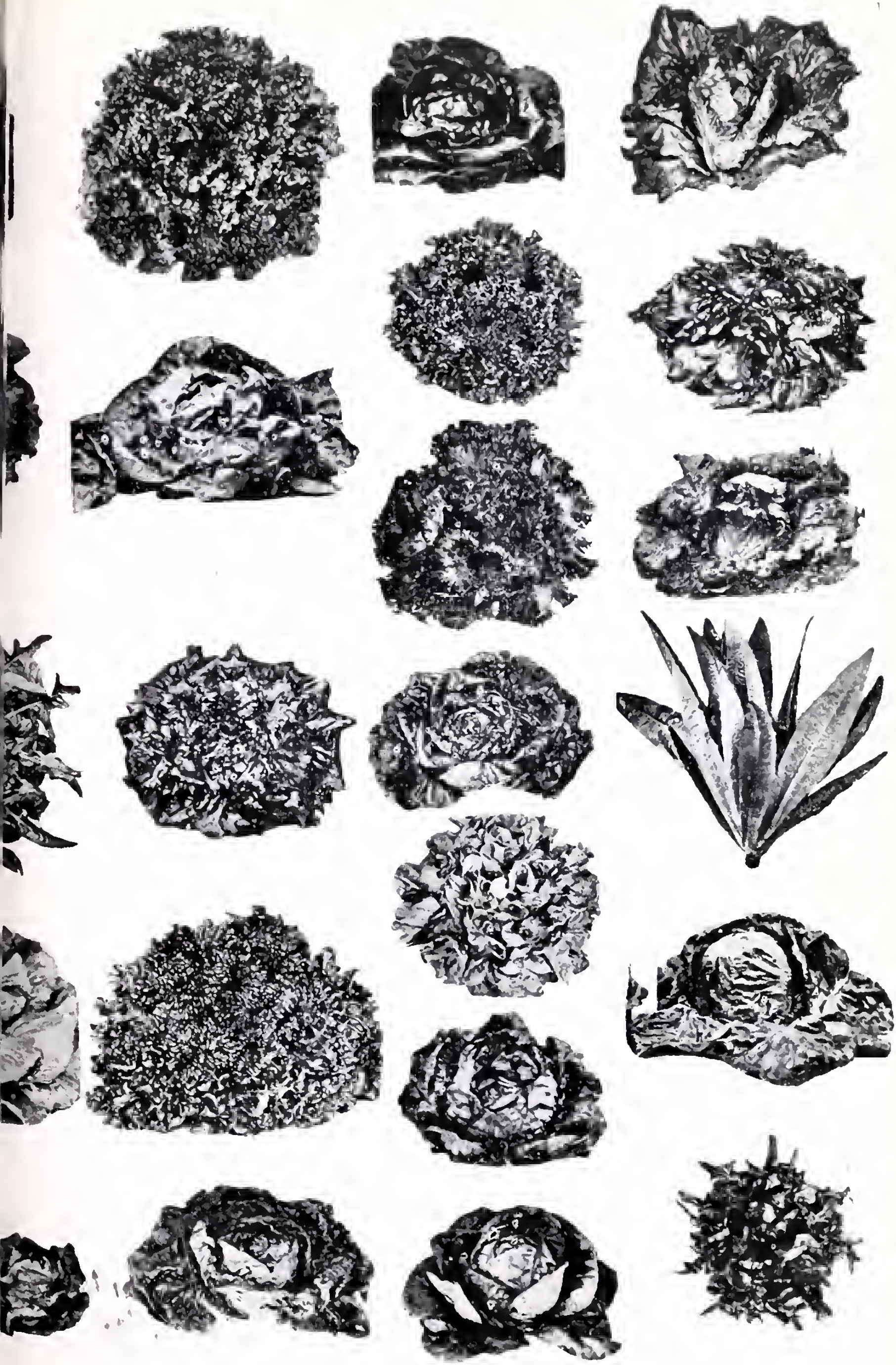


Fig. 3. Typical specimens in the rosette stage of 42 varieties of cultiv



, *Lactuca sativa* L. (After W. W. Tracy, U. S. Dept. of Agriculture.)

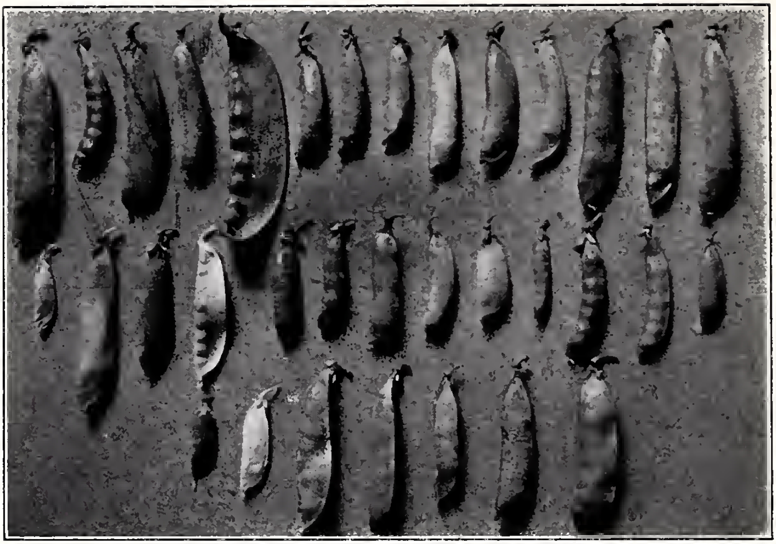


Fig. 4. Typical pods from thirty-four varieties of peas, showing enormous variability in hereditary pod length. Several wild types are represented. Quite Content and Goldkönig are two of the largest parchmented-pod varieties, while the fifth pod in the top row represents probably the longest podded pea known, the pods sometimes reaching 6 inches long and over an inch in width. These colossal pods are non-parchmented, very sweet and are eaten like string beans.

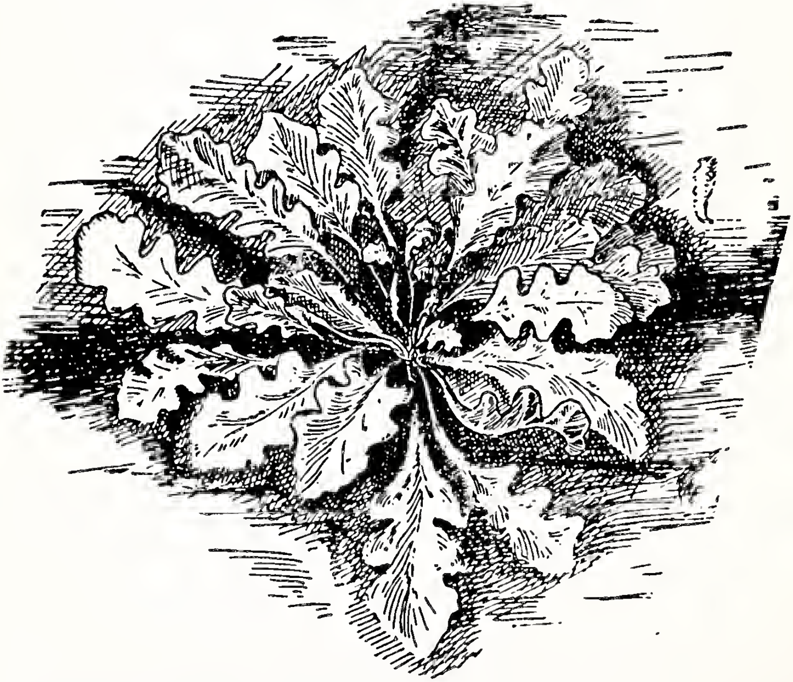


Fig. 5. Sketch of the wild ancestor of the cabbage, as it occurs on the chalk cliffs of Dover, England. After L. H. Bailey.

terranean highlands, it more nearly resembles our conception of a weed than a valuable vegetable possibility. One wonders what primitive white man could see in this uninviting, bitter cliff weed, to cause him to throw about it his special care. But on this, as on the nature of woman, man can only speculate, for the eating of cabbage goes back far beyond our historical records and traditions. Among the Greeks it was held in little esteem, but the Romans were even poetic in its praise—a kind of praise accorded but rarely these modern days to such prosaic food. The Roman varieties are believed to have been of the loose, flat-headed type, the varieties with conical heads being considered as quite modern, possibly resulting from accidental crosses with the Chinese cabbage. Cabbages were cultivated by the ancient Celts of Scotland, and perhaps several of our forms were brought from Asia by the early migratory hordes. There are said to be no taxonomic varieties of the wild cabbage although it is a very variable species. Of cultivated varieties—their name is legion. For it is impossible to call to mind a plant that has varied so in every part of its structure, from the shape of its roots to the crown of its flower stalk. Three hundred or more years ago, a turnip-rooted form was grown in Bavaria and a somewhat similar form is now grown in some parts of France. In kohl-rabi, the stem has changed into a juicy mass of edible tissue; in the common "boiled dinner," sauer-kraut, slaw type of cabbage, the stem spaces between each leaf (internodes) have become shortened and a head formed, a character present only to a very limited extent in the wild type, and according to Darwin not present at all in cultivated cabbage grown in hot countries. In leaves, variation has given us the crinkly Savoy and red types. Cauliflower and broccoli are simply cabbages in which the flowering stalk is much shortened and increased in size and the development of many closely packed aborted flower buds brought about. In brussels sprouts, a large number of small heads have been substituted for the usual single large head. The Georgia collards are headless like the wild cabbage, as is also the kale and the giant cabbage kales of Wales and the Channel Islands. The latter produces stems of sufficient height to make canes and to use as cow-shed rafters, a length of 8-9 feet being not uncommon.

When and where these numerous variations occurred, the records tell us but little. Cauliflower appears to have been known to the Greeks and Romans in a form somewhat resembling a poorly grown broccoli. According to Pickering, cauliflower was first mentioned in 540 B. C. A German writer, Hehn, says true cauliflower is of eastern origin and came to Europe via Venice and Antwerp. In the 12th century, the Moors of Spain are said to have written about it and to have received it from Syria. When first brought to western Europe, it was called "cabbage of Cyprus" possibly referring to the place where the best seed was grown. Brussels sprouts, kohl-rabi and forms corresponding to collards seem to have been known in ancient times as also were the red and Savoy types. Sauerkraut, strange as it may seem, is said to have been introduced into Germany, through Russia, from Asia.

Almost as remarkable as the diversity of cabbage forms, are those coming from the wild lettuce, a roadside weed many of you no doubt have trampled under foot many times without ever once associating it with the toothsome salad of your dinner courses. This common waste-land weed, *Lactuca scariola,* is not at first sight a very prepossessing forbear, and many a gardener would look in vain for resemblances to our cultivated lettuces. But to the botanist the mature plants of the wild and cultivated forms are very similar, and the differences which the epicurean and the gardener see are only minor and insignificant ones. Especially are these differences decreased when one contrasts a well grown plant of the wild lettuce with a somewhat poorly grown Romaine lettuce. Further, Professor Durst of the University of Illinois has made crosses between the wild and cultivated types, thus forging another link in the chain of evidence proving their close relationship. Although native to certain temperate portions of Eurasia, this weed has become common in most civilized countries. The botanist Boissier, mentions a wild variety with crinkled leaves, which came from the mountains of western Asia. As to varieties, three are said to have been cultivated 2,000 years or more ago by the Greeks, while now 100 or more distinct varieties are common, of which the illustration shows 42 of the most important. The kings of Persia had lettuce salad on their tables in 300 B. C. The Moors of Spain grew several types, among them the Romaine. In fact, all ot our present day types—the head, the Romaine, the curly loose leaved, the oak leaved and others—seem to have been well known in Europe preceding the middle ages.

From the kinds sold in our markets, one would never guess that peas exist in distinct varieties to the number of five hundred or more. These various kinds are grown in almost every temperate region of the world, including the Abyssinian plateau and the desert oases of Turkestan in western China. They differ from one another in seed color, shape, texture, sugar content, size; in number of peas per pod, in number of pods per plant (4-400 or more); in time of blooming; in time of maturing; in shape, size (1-5.5 inches), color (purple, canary yellow, green), texture of pod; in shape, size, color (red, pink, white), and number of flowers; in height of plant (6 inches to 10 feet); in shape, size and color of leaves; in number of branches and in the presence or absence of tendrils. Some varieties have bloomed, ripened their seed and died before others have reached the flowering stage. Some varieties will endure heat, others will endure more cold. Some varieties will mature seed where other varieties will be an absolute failure. Some varieties have pods which are used like string beans, while others have a pod that would be as edible as dry corn husks. Such edible podded varieties are common in our Chinese markets. Most of these types probably were known to the Romans. The possible exception is the wrinkled-seeded peas, which by some authorities are said to have been discovered and introduced by the pioneer horticulturist, Thomas Knight, about a century ago. Perhaps this form occurred as a mutation in his experimental cultures, and realizing its value, he saved it. The edible podded peas were introduced into France from Holland about 1600 and soon took society's fancy. "The subject of peas continues to absorb all others," writes Madame de Maintenon in 1696, "the anxiety to eat them, the pleasure of having eaten them, and the desire to eat them again, are the three great matters which have been discussed by our Princes for four days past. Some ladies even after having supped at the Royal table, and well supped too, returning to their own homes, at the risk of suffering from indigestion, will again eat peas before going to bed. It is both a fashion and a madness."

Botanists consider that some of the round, smooth seeded field peas with colored seed coats most closely resemble the wild ancestral species. DeCandolle believes western Asia was probably the original home of the pea, as there is every reason to believe its cultivation in eastern and southern Asia is comparatively recent. The Swiss lake dwellers of the Bronze Age had a small variety of pea said to somewhat resemble the "wild" field pea of southern Europe, and this is probably the earliest record of the cultivation of peas we possess. The writer has a large collection of peas, including many wild species and varieties from western and central Asia. From a study of these it appears most likely that our cultivated varieties arose from several wild forms belonging to the same species.

In contrast to the pea, cabbage, lettuce, and corn, cultivated asparagus is readily identified with its wild ancestor, a plant that to-day covers the waste steppes of south Russia by the billions, furnishing pasturage for thousands of horses and cattle. Although grown for over 2,000 years as a vegetable, there is very little distinction between the modern "most improved" varieties and those from these wild pasture lands. Why some plants such as this vary but little while others vary greatly is still one of the unsolved mysteries of heredity and variation.

Often associated in the dinner courses with such nutritious vegetables as peas and potatoes, are greens and buttered beets, these latter serving as roughage or "bulk." As for greens, they seem to have been in vogue from time immemorial and to have consisted of innumerable early spring plants that are tender, non-poisonous and at all eatable. Burdock, dandelion, lamb's quarter, wild mustard, and spinach are examples of the best known. The chards are beets with slender roots and large leaves, often with thick midribs. Together with the common red beet and the sugar beet, they trace their ancestry back to the common wild beet of Europe and Asia, although some authorities believe the chard to have come from a separate species, *Beta Cicla* L. This is often regarded as a form of *B. vulgaris.* Chard is of ancient cultivation, but the beet root was in all probability not eaten by the Greeks and Romans. In fact, beet roots as vegetables were little known in England as late as 1597. Lobel, writing in 1576, describes the turnip-rooted beet as "within and without wholly red, suffused with bloody gore, sweeter to the taste." Gerarde in his "Herball" (1597) writes: "What might be made of the red and beautifull roote (which is to be preferred before the leaves, as well in beautie as in goodnesse), I referre vnto the curious and cunning cooke, who no doubt, when he hath had the view thereof, and is assured that it is both good and holesome, will make thereof many and divers dishes both faire and good." The wild beet is a perennial, while the cultivated forms are biennials. The broad, flat-ribbed form of chard is of modern origin, although much older than several seed-catalogs indicate.

The dandelion is mentioned by Omar Khayyam as "that green herb" and probably originally migrated from Asia, although wild forms have been found isolated on certain mountain groups of our western states, possibly stranded there by the glacial "floods." Its use as food is comparatively modern, our liking for it having developed through its association with us as a medical herb. The chicories, including the endives, are still very wild looking. and show but slight effect from their 2,000 years or more sojourn with man. The endive chicory is a common annual weed in Sicily and in the grainfields of Egypt, just as its blue flowered perennial cousin, the ancestor of the witloof endive, is a common weed in the United States. The two cresses, the garden and water, have come to us as vegetables through association with us as simples or medical herbs. The same is true of celery, the ancestor of which abounds as a marsh, brook and drainage ditch plant in England and other parts of Europe. Celery is said to have been first blanched about 1670. In ancient Rome and Greece, it was regarded as a sort of parsley and in Malta and many parts of the Near East, even to-day celery is not blanched but the leaves are used as flavoring or as garnish. One of the English herbalists some 400 years ago wrote "this is not woonted to be eaten, neither is it counted good for sauce." The popular Giant Pascal variety originated about 1890. Rhubarb is still another plant that was first a medicine, and then a vegetable, for in Elizabethan times, the leaves were regarded as the finest sort of greens. Only since the beginning of the 19th century has it been used for sauce, pies and tarts. The leaves are said to be unwholesome for some people, so they are rarely used for greens in these days. The ancestral wild type is common along the Volga River in Russia, while the mountains of eastern Asia are full of closely related species.

Turnips, carrots, parsnips and radishes trace their ancestry back to a very weedy, "seedy" lot of forbears, which many of them tend to resemble even now when growing conditions are not of the best, as is the case with most of my neighbor's radishes. Long, stringy, woody, wiry roots about an eighth of an inch in diameter with very large healthy tops are all that his arduous labor in amateur gardening has brought him. So that upwards of 3,000 years of cultivation have not done much for this vegetable. In the Far East are several queer forms of radishes, one known as rat-tail radish has seed pods often over a foot long, and these are pickled as capers. In Japan, the cost of living is partly deduced from the cost of daikon, the giant winter radish, which is one of the principal winter vegetables of the poor people. On the Great Pyramid of Egypt, there is said to be an inscription in Egyptian characters, telling how much was expended in radishes, onions, and garlic for the workmen. *Daucus Carota* or Queen Anne's Lace is the wild form of the cultivated carrot. Both it and parsnips are so variable that improved varieties have been obtained directly from wild plants by a few generations of selection. Giant rooted forms of carrot are known in the Orient.

Perhaps in an account of this sort, one should not forget to give honorable mention at least to the pungent horse-radish and the odoriferous alliums. The former is a somewhat common wild plant in eastern Europe, in Finland and Russia and in western Siberia and Turkey. Horse-radish is another one of the many vegetables we have received through the medieval gardens of medicinal herbs. Gerarde, an old herbalist, tells of the antipathy between the horse-radish and the grapevine. He writes: "Divers thinke that this Horse Radish is an enimie to Vines, and that hatred between them is so great that if the rootes heerof be planted neere to the vine, it bendeth backward from it as not willing to have fellowship with it." Another 16th century authority writes advising the use of the roots as a condiment in case only of strong laboring men, as "it is too strong for tender and gentle stomaches."

The onion tribe has been long with us, all of them except chives being of ancient cultivation. The Romans avoided garlic on account of its offensive odor, but the Emperor Nero used leeks and oil for his voice. In some countries they were associated with religious ceremonies, and in Egypt, the garlic was sacred to the swearing of oaths. At least seven distinct species, no doubt including many forms, have contributed the numerous cultivated varieties. *Allium Cepa* is the most important of these, for from it the many ordinary kinds of onions have been derived. This species, as well as the others, are still common in a wild state in Eurasia.

In the more or less haphazard process of finding suitable vegetables, many species have been tried out and for some reason cast aside, so that our present common vegetables are a selected lot, even though the selection has been often largely determined by chance.

A table of the various vegetables giving their names, scientific names, probable antiquity of cultivation and their country of origin, is appended. The letters indicate the probable length of cultivation.

A—a species cultivated for more than 4,000 years.
B—a species cultivated for more than 2,000 years.
C—a species cultivated for less than 2,000 years.
D—a species cultivated very anciently in America.
E—a species cultivated in America before 1492 without giving evidence of great antiquity of culture.
F—a species or subspecies of very recent domestication.

Common Names	Scientific Name	Date	Origin
Artichoke, Globe	*Cynara Scolymus* L.	C	Southern Europe, Northern Africa, Canary Islands.
Artichoke, Jerusalem	*Helianthus tuberosus* L.	E	Eastern North America.
Asparagus	*Asparagus officinalis* L.	B	Europe, Western temperate Asia.
Bean (Broad or Windsor)	*Vicia Faba* L.	B(?)	Temperate Europe.
Bean (Pole Lima)	*Phaseolus lunatus* L.	E	Tropical America, Peru, Brazil.
Bean (Bush Lima)	*Phaseolus lunatus* L.	F	Eastern North America.
Bean (String, etc.)	*Phaseolus vulgaris* L.	D	Western South America.
Bean (Tepary)	*Phaseolus acutifolius* Gray	D	Southwestern United States.
Bean (Adzuki)	*Phaseolus angularis* Willd.	B(?)	China, Japan.
Beet (Chard)	*Beta vulgaris* L.	B	Canary Islands, Mediterranean region, Western temperate Asia.
Beet (Root)	*Beta vulgaris* L.	B	Europe, Mediterranean region.
Broccoli	*Brassica oleracea* var. *botrytis* DC.	B	Western Asia.
Brussels sprouts	*Brassica oleracea* var. *gemmifera* DC.	C	Belgium (?)
Cabbage	*Brassica oleracea* L.	A	Western Asia.
Cabbage (Chinese)	*Brassica Pe-tsai* Bailey	B	China, Japan.
Carrot	*Daucus Carota* L.	B	Europe, Western temperate Asia.
Cauliflower	*Brassica oleracea botrytis* DC.	B	Western Asia.
Celeriac	*Apium graveolens* L. var. *rapaceum* DC.	C	Europe.
Celery	*Apium graveolens* L.	B	Temperate and Southern Europe. Northern Africa, Western Asia.
Chives	*Allium Schoenoprasum* L.	C	Temperate Europe, Siberia, Northern North America.
Corn (field)	*Zea Mays* L.	D	Mexico, Northwestern South America (?)
Corn (sweet)	*Zea Mays saccharata* Sturt.	E	Eastern North America, New England.
Cress (garden)	*Lepidium sativum* L.	B	Persia(?).
Cress (water)	*Radicula Nasturtium-aquaticum* L.	B	Europe, Northern Asia
Cucumber	*Cucumis sativus* L.	A	India.
Cucumber (gherkin)	*Cucumus Anguria* L.	F	West Indies.
Dandelion	*Taraxacum officinale* Weber	C	Europe and Asia.
Egg Plant (aubergine)	*Solanum Melongena* L.	A	India, East Indies.
Endive	*Cichorium Endivia* L.	C	Mediterranean region. Caucasus, Turkestan.
Garlic	*Allium sativum* L.	B	Kirghis desert region in Siberia.
Horse-radish	*Roripa Armoracea* L.	C	Eastern temperate Europe, Western Asia.
Kale	*Brassica oleracea* var. *acephala* DC.	B	Europe.
Kohl-rabi	*Brassica oleracea* var. *Caulo-Rapa* DC.	B	Europe.
Leek	*Allium Porrum* L.	B	Mediterranean region, Egypt.
Lentil	*Lens esculenta* Moench	A	Western temperate Asia, Greece.
Lettuce	*Lactuca sativa* L.	B	Southern Europe, Western Asia.
Mushroom	*Agaricus campestris* L.	C	Northern hemisphere (Europe).
Okra (gumbo)	*Hibiscus esculentus* L.	C	Tropical Africa.

COMMON NAMES	SCIENTIFIC NAME	DATE	ORIGIN
Onion	*Allium Cepa* L.	A	Persia, Central Asia.
Onion (Welsh)	*Allium fistulosum* L.	C	Siberia, Kirghis desert region to Lake Baikal.
Parsley	*Petroselinum Hortense* Hoffm.	C	Southern Europe, Algeria, Lebanon.
Parsnip	*Pastinaca sativa* L.	C(?)	Central and Southern Europe.
Pea (garden)	*Pisum sativum* L.	A	Western and Central Asia, Southern Europe, North India(?).
Pea (wrinkled garden)	*Pisum sativum* L.	F	England (?).
Pea (edible podded)	*Pisum sativum* var. *saccharatum* Hort.	C	Holland, etc.
Pepper (red)	*Capsicum annuum* L.	E	Brazil, Western South America.
Potato	*Solanum tuberosum* L.	E	Chile, Peru.
Potato (sweet)	*Ipomoea Batatas* Poir.	D	Tropical America.
Pumpkin	*Curcurbita pepo* L.	E	Sub-tropical and tropical America.
Radish	*Raphanus sativus* L.	B	Temperate Asia.
Radish (Japanese Giant or Daikon)	*R. sativus* L.	(?)	Japan, China.
Rhubarb	*Rheum Rhaponticum* L.	C	Desert and sub-alpine regions of Southern Siberia, Volga River.
Rutabaga	*Brassica oleracea* var. Napo-Brassica L.	C	Europe.
Salsify or Oyster plant	*Tragopogon porrifolius* L.	C(?)	Southeastern Europe or Algeria.
Spinach	*Spinacea oleracea* L.	C	Persia, S. W. Asia.
Spinach (New Zealand)	*Tetragonia expansa* Thumb.	F	New Zealand.
Squash (winter)	*Cucurbita maxima* Duch.	E or D	Tropical America.
Squash (summer)	*Cucurbita Pepo* L.	E	Temperate or tropical America.
Tomato	*Lycopersicum esculentum* Mill.	F	Peru.
Tomato (currant or raisin)	*L. pimpinellifolium* Dumal	F	South America.
Turnip	*Brassica Rapa* L.	A	Europe.
Yams	Several sp. including *Dioscorea alata* L. and *D. Batatas* Decne.	B(?)	Southeastern Asia, Africa and South Pacific Islands.

ORLAND E. WHITE.

NOTICES

The Garden is open free to the public daily, from 8 a.m. until sunset; on Sundays and holidays at 10 a.m. The Laboratory Building, containing the library, herbarium, and offices, is open daily, from 9 a.m. until 5 p.m. The Conservatories are open April 1–October 1, 10 a.m.–4:30 p.m.; October 1–April 1, 10 a.m.–4 p.m.

The Garden may be reached by Flatbush Ave. trolley to Malbone St.; Franklin Ave., Lorimer St., and Tompkins Ave. trolleys to Washington Ave.; St. John's Place and Rogers Ave. trolleys to Sterling Place; Vanderbilt Ave., Sixteenth Ave., Union St., Greenpoint, and Smith St. trolleys to Prospect Park Plaza and Union St., and Brighton Beach elevated to Consumers' Park Station. (The elevated trains stop only when the conductor is notified in advance.)

A docent will meet parties by appointment and conduct them through the Garden. This service is free to members of the Botanic Garden and to teachers with classes; to others there is a nominal charge of 25 cents an hour for parties of less than three, and 10 cents a person per hour for parties of three or more.

Subscription for LEAFLETS **fifty cents a series** (comprising about fourteen numbers); free to members of the Botanic Garden and to teachers.

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BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES VI　BROOKLYN, N. Y., MAY 29, 1918　NO. 4

POTATO DISEASES*

Potatoes lead all other other crops in world's food production. Over 5,000,000,000 bushels (of which Europe grew 90 per cent) were averaged annually throughout the whole world for the past ten years. Potato growing is also said to yield more return for capital and labor invested than any other crop. After the sovereign spud, follows in decreasing order corn, wheat, oats, then rice; although if we had accurate statistics as to rice growing in China, the latter would undoubtedly be placed much higher as a world feeder.

It is estimated that, in 1915, the average yield per acre of potatoes in the United States was 96 bushels; while the next year it decreased to about 80 bushels. On the other hand, Great Britain and Ireland, from 1904-1913, averaged 210 bushels, and Germany, 200 bushels per acre. We can take some comfort, however, in the fact that the world's record for yield is held in America, when Mrs. Jones, of Chautauqua County, N. Y., grew in 1888 on a plot of $\frac{1}{20}$ of an acre, potatoes at the rate of 1061 bushels to the acre! While it is true that Europe is not pestered with potato bugs, and also that the northern countries have the cool climate which potatoes prefer, we must acknowledge nevertheless the probability that Europe takes better care of her crop than we.

For instance, the potato crop in the United States is reduced each year by more than 100,000,000 bushels as the result of injury, largely preventable, by insects and diseases. In New York State alone, in 1912, 20,000,000 bushels of potatoes were lost through late-blight. Such losses may be largely avoided by the methods explained below. As good business men, we should, especially in these critical times, stop all avoidable leaks in crop production.

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*For further information on this subject, consult Gilbert's **"The Potato"**, published by the Macmillan Co., N. Y., 1917 (especially chapters X, on "Diseases of the Potato" and XI, on "Control Measures against Diseases", by Dr. M. F. Barrus); Farmer's Bulletin No. 856, on **Control of Diseases and Insect Enemies of the Home Vegetable Garden;** Farmer's Bulletin No. 868 on **How to Increase the Potato Crop by Spraying;** as well as other publications (e. g. Bulletins 544, 64, etc.) of the United States Department of Agriculture on potato diseases.

In the following brief account only the plant diseases and not the insects are considered. As will be seen, the total list of potato diseases is a formidable one; but, fortunately, we have remedies for most of them; while others, like chestnut-blight, still remain unsolved.

We may classify potato diseases according to their causes as follows:

* Caused by Parasitic Diseases (Contagious)	Fungous—*Early blight;* **late-blight,** or **downy mildew;** Fusarium dry-rot; **Fusarium wilt; Verticillium wilt; Rhizoctonia,** or **Russet scab;** potato wart, silver scurf; leak. Bacterial—Common scab; **black-leg;** soft rots: **bacterial wilt.** Slime-mold—Powdery scab.
Supposedly Non-Parasitic, but heritable through seed	**Curly dwarf; mosaic** (?); **leaf-roll** (transmissible through contact).
Non-parasitic (Not contagious)	**Spindling sprout;** internal brown spot; net-necrosis; blackheart; *tip-burn, sun-scald; arsenical poisoning;* formaldehyde injury; *lightning injury;* **frost injury.**

*Diseases in ordinary type affect mainly the tubers.
Diseases in *italics* affect mainly the plant above ground.
Diseases in **heavy face** type affect both tubers and foliage.

The above list may at first glance even tend to frighten one away from raising potatoes, especially when we consider that the insect troubles are to be added to the above. But, as mentioned above, we have remedies for most of these diseases. These remedies we may group under *seed selection*, *seed disinfection*, and *spraying*. To these should also be added *rotation of crops*.

The ideal way to raise potatoes is to plant clean seed, obtained from healthy plants and hence free from disease, on soil which has been properly fertilized and rotated to other crops for a period of 3-5 years. It is usually recommended, particularly in more southern localities, to plant seed raised farther north. At times (and this seems to be particularly true this year) seed potatoes come to us badly diseased. If these tubers are carefully selected, or sorted over, before planting and all discarded that show disease, either externally or internally, or any signs of bruising or decay, or discoloration of the flesh, most of the above diseases can be largely avoided. In some cases, in order to insure healthy seed, it may even be necessary for the potato seed grower to go into his fields and there "rogue" the growing crop in order to detect and pull out the "rogues", such as those affected by blackleg, leafroll, curly dwarf, or wilt diseases. This field inspection should be done at least twice: once during blossoming time, and again just before harvest.

Seed disinfection with formaldehyde (formalin).—This treatment is designed mainly for common potato-scab and for black-leg. The potatoes should be soaked 2 hours in a solution containing 1 pint of formaldehyde to 30 gallons of water. This may be used over and over again for at least ten times without losing much strength, provided that the barrel containing the solution be kept well covered.

It should be remembered that the treatment will do but little good if the soil to be planted is already infested with scab or black-leg from former crops. The fact that some of these diseases may live over in the soil for three years or more, gives us, in fact, one of our main reasons for **rotation of crops.**

Seed disinfection with corrosive sublimate (mercuric chloride).—This treatment is more effective than formaldehyde for the Russet Scab, or Black Scurf, disease of the tubers. They should be soaked 1½ hours in a solution containing 4 ounces of the corrosive sublimate (which is *very poisonous*) in 30 gallons of water. First dissolve the powder in a quart or two of warm water, then add to the rest of the water. Do not use metal containers, as the solution combines rapidly with metal and thus loses its efficiency.

Spraying.—Bordeaux Mixture is the standard spray material for potatoes, especially for the dreaded late-blight. It was discovered more or less accidentally in 1882 by Professor Millardet, of Bordeaux, that a mixture of milk of lime and bluestone made grape-vines on which it was sprinkled more resistant to mildew. It had been the custom in certain vineyards in France to sprinkle a few rows of vines near the road with this mixture, in order to give them a poisonous appearance to scare off the hungry passers-by; and Professor Millardet, noticing that these sprinkled plants were healthier, begun to experiment, shaking the Bordeaux Mixture on to the plants with a broom.

One of the most interesting things about Bordeaux Mixture so far discovered is that it has, aside from its fungicidal power, much value as a stimulator of plant activities. The sprayed potatoes are greener and remain alive longer than unsprayed vines. Even though late-blight, early-blight and tip-burn be not in evidence, spraying has been found to pay, for this other reason.

The spraying should begin when the plants are about 6 to 8 inches high, or when the eggs of the first brood of potato bugs begin to hatch. From 5 to 8 applications are usually made, at intervals of 10 days to 2 weeks, depending on the weather conditions; from 50 to 75 gallons to the acre being required at first; later, from 100 to 150 gallons.

To make Bordeaux Mixture (4—4—50)—Copper sulphate, 4 lbs; quick lime, 4 lbs; water, 50 gallons. (Add 3 lbs. lead arsenate to kill insects).

Dissolve the copper sulphate by suspending in a coarse bag over night in 25 gallons of water. Slack the quick lime in a small amount of water (4 gallons, e. g.), and stir when fully slacked into 25 gallons of water. Pour the two solutions together, stirring constantly, through a strainer into a barrel or vessel holding 50 gallons. *Spray at once*, as the Bordeaux Mixture loses much of its efficiency within a few hours.

Those who have much spraying to do are advised to make up stock solutions of the two ingredients, which keep indefinitely—at the rate of 1 lb. to 1 gallon of water.

It is especially advisable to make such a stock solution of lime, since quick lime will not keep long, while the milk of lime does. One may to advantage slack a large quantity of lime and mix with water at the rate of 1 lb. of lime to 1 gallon of water. Keep in a covered barrel or vessel, and, when needed, stir well and use 1 gallon of stock solution for each pound required.

Diseases found in the potato tuber	Remedy
1. Affecting the skin of the potato tuber.	
Common scab	Soak seed 1½ to 2 hours in formaldehyde. Plant in soil free from scab.
Russet Scab (Black Scurf, or Rhizoctonia)	Soak seed 1½ hours in corrosive sublimate. Plant in clean soil.
Powdery scab	Do not plant affected tubers.
Potato wart	Ditto
Silver scurf	Ditto
2. Affecting the stem of the growing plant and vascular system.	
Black-leg (blackens the lower part of stem)	Reject all bruised or cracked tubers and soak selected seed in formalin. Remove diseased plants from field.
Fusarium wilt (This and the two following causing tuber flesh discolorations)	Do not plant tubers showing darkening at stem end.
Verticillium wilt	Ditto
Bacterial wilt	Ditto
Spindling sprout	Reject tubers with weak sprouts.
3. Causing tuber rots and flesh discolorations.	
Late-blight (also affects the leaves) dry-rot (Phytophthora)	Do not plant affected tubers showing brown discoloration extending in from skin. (Spray foliage with Bordeaux mixture).
Jelly-end rot and dry-rot (Fusarium)	Do not plant affected tubers.
Potato leak (a storage rot)	Avoid wounding potatoes.
Blackheart (occurs mainly in overheated cars and storage bins)	Avoid high temperatures and ventilate bins.
Internal brown spot (scattered irregularly through the flesh)	Do not plant affected tubers.
Net-necrosis (brown streaks affecting mainly the vascular part of the tubers)	Ditto
Eelworms (causing glistening spots under skin)	Ditto
4. Causing often small tubers, but otherwise difficult, if not impossible, to detect in the tubers.	
Curly dwarf; leaf-roll; mosaic	Inspect twice in fields: while blooming and shortly before harvest. Discard diseased plants for seed.

E. W. Olive.

CHILDREN'S NUMBER

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES VI BROOKLYN, N. Y., JUNE 12, 1918 No. 5

FIFTH ANNUAL GARDEN EXHIBIT FOR BROOKLYN BOYS AND GIRLS

For five years we have been working with you, the teachers and children of the Borough of Brooklyn. I think if we could gather all our work together we would find that the Borough of Brooklyn stands high in what New York City has been doing in the line of gardening.

It is rather interesting to note that at our last exhibit the number of entries in the class for flowers was small, while the number in the classes for vegetables and school garden displays was greater and finer in individual specimens than ever before. The reason for this is the emphasis that was put on war gardens, and our united work for four years. We should have this year better war products than ever before, and, to stimulate the best endeavor, the Chairman of the Botanic Garden Governing Committee of our Trustees has offered to give certain prizes for the duration of the war. These prizes are in the form of War Savings Stamps (Class K, *a* and *b*). Please bring this to the attention of every child in your school, and if you desire extra copies of this LEAFLET please write to us at once for them and we will send them to the school. Children who are going to work for the best back yard gardens should send us their names, or the names should be sent to us through the school.

Please note also that our exhibit is to be on September 13 and 14 and that the exhibits should be brought to the Garden during the day of the 12th, any time from 8:00 o'clock in the morning until 5:00 o'clock at night. The exhibits will be judged by three impartial judges on the 13th, and will be on exhibition for the public from 3:00 to 5:00 of that day. On the following day the exhibit will be open from 10:00 o'clock in the morning until 4:00 o'clock in the afternoon. At 4:00 o'clock any child is permitted to take his exhibit away. Be sure to say to your children that each separate exhibit, unless it be a part of the class or school exhibit, must have an entry card with the exhibitor's name, school, and address upon it. These entry cards may be obtained from us in early

September, and should be filled in exactly as indicated. Let us have a tremendous showing this year of what the Borough of Brooklyn can do at its Annual Garden Exhibit.

Class A—**School Display.** First prize, a trophy to the school making the best display, to be held for a year at a time until won three times, when it becomes the permanent property of the winning school. Second prize, a silver cup. Last year P. S. 98 held first place in *Class A* and won our new trophy, a bronze placque of our own children's gardens. This year we want some new schools to try for this. See if this year your school cannot send in the best collection of vegetables, flowers, and plants. These may be raised either at schools or in home gardens.

Class B—**Roof Garden Display.** If you do not have a back yard here is a chance for you to see how attractive you can make your roof. Either flowers or vegetables may be raised. The roof gardens will be visited by us three times during the summer. The class is open to individual children, families of children, schools, and settlement houses. First and second prizes will be awarded. First prize is a bronze statue (which must be won three times), held now by P. S. 43. Second prize is a silver cup.

Class C—**Box Display.** This display will consist of plants and flowers in boxes, and of potted plants. There are schools where it is impossible to have a school garden, and where the neighborhood is such that it is impossible to have home gardens; for such this class is added. First prize, a cup. Second prize, a cup.

Class D—**Flowers.** This is a class for individual competition, and in which first and second prizes are offered. In this and the following classes the first prizes are silver medals; second prizes, bronze medals. Certificates of honorable mention will also be awarded. If a boy or girl enters an individual class, he must understand that these same products cannot count toward his school display. Double entries should be made in such cases. Do not forget this. If you enter zinnias for an individual prize and wish to add zinnias to the school display, then you must bring two bunches of zinnias. The divisions in *Class D* are as follows:

- No. 1. Ageratum
  - Best 4 sprays
- No. 2. Alyssum
  - Best plant (potted)
- No. 3. Asters, blue
  - Best collection of 10
- No. 4. Asters, pink
  - Best collection of 10
- No. 5. Asters, white
  - Best collection of 10
- No. 6. Asters, mixed
  - Best collection of 12
- No. 7. Asters
  - Best plant (potted)
- No. 8. Calendula
  - Best collection of 8
- No. 9. Cornflower
  - Best collection of 12
- No. 10. Dianthus
  - Best collection of 10
- No. 11. Marigold
  - (Giant African)
  - Best collection of 12
- No. 12. Marigold
  - (Dwarf French)
  - Best collection of 12
- No. 13. Marigold
  - Best plant (potted)
- No. 14. Nasturtium
  - Best collection of 12
- No. 15. Phlox
  - Best collection of 8
- No. 16. Sunflower
  - Largest flower
- No. 17. Verbena
  - Best collection of 10
- No. 18. Zinnia
  - Best collection of 10

Class E—**Vegetables.** Surely this ought to be a popular class this year. Plan ahead so your vegetables will be in their prime at exhibit time. Try to send in perfect specimens. If, for example, you are exhibiting under No. 17, red tomatoes, have your eight tomatoes as near the same size as possible. Wash your vegetables carefully, so that they make an attractive appearance. First prizes in this class are silver medals; second prizes, bronze medals; third prizes, certificates of honorable mention.

Divisions in Class E

No. 1. Beans, bush
Best pint, shelled
No. 2. Beans
Best quart, unshelled
No. 3. Beets
Best bunch of 6
No. 4. Carrots
Best bunch of 5
No. 5. Cabbage
Best head
No. 6. Corn
Best 6 ears
No. 7. Egg plant
Best 2
No. 8. Kohlrabi
Best 4
No. 9. Lettuce
Best 2 heads
(roots and all)
No. 10. Onions
Best 4
No. 11. Peppers
Best 4
No. 12. Potatoes
Best 6
No. 13. Pumpkin
Best specimen
No. 14. Radishes
Best 8
No. 15. Squash
Best specimen
No. 16. Tomatoes, green
Best 8
No. 17. Tomatoes, red
Best 8
No. 18. Tomatoes
Small-fruited varieties
Best 10

Class F—**Best Special Plant.** Any plant cared for by the exhibitor may be entered. The plant may be a geranium raised from a cutting, an aster from seed, a fern from a runner—it matters not so long as the work is yours. The plant stands no chance of prize winning if it is not in good condition, clean, properly potted, and free from insect pests. First prize, a silver medal; second prize, a bronze medal; third prize, a certificate of honorable mention.

Class G—**Best Bunch of Flowers.** Judged on perfection of the flowers and taste in arrangement. First prize in this class is a silver medal; second prize, a bronze medal; third prize, a certificate of honorable mention.

Class H—**Individual Garden Display.** The greatest variety of flowers or vegetables raised by one child constitutes this display. Here is an opportunity to show some originality and taste in the way you put together and arrange your own exhibit. Let us have more exhibits in this class this year. First prize, a silver medal; second prize, a bronze medal; third prize, a certificate of honorable mention.

Class I—**Weed Display.** This weed exhibit may be one of either fresh or pressed specimens. No exhibit can take a prize unless the specimens are carefully and correctly named. If you go away to the country in the summer you will have a good opportunity to make a large collection of weeds and wild flowers for the exhibit.

FIRST PRIZE is a silver medal; SECOND PRIZE, a bronze medal; and certificates of honorable mention will be awarded to those taking third places.

Class J—**Wild Flowers.** Similar to *Class I.* FIRST PRIZE, a silver medal; SECOND PRIZE, a bronze medal; THIRD PRIZE, certificates of honorable mention.

Class K (*a*)—**Back Yard Gardens.** Boys: $15.00 IN WAR SAVINGS STAMPS will be presented to the boy having the best back yard garden in Brooklyn. $10.00 IN WAR SAVINGS STAMPS will be given to the boy having the second best back yard garden. Conditions for these prizes are as follows: First, the garden must be kept by the applicant; second, the garden must be at least 10x20; third, plans, diagram, cost of seed, amount of crop must be all submitted in writing to the Botanic Garden at the time of the exhibit. These gardens must be entered in this contest by July 1st, and will be visited at least twice during the season by a judge from the Botanic Garden.

Class K (*b*)—Same for girls as *Class K* (a).

THE ALFRED T. WHITE SCHOLARSHIP

Besides these prizes the Chairman of the Governing Committee of the Brooklyn Botanic Garden is offering the sum of $100.00 as a scholarship for any college, to the boy or girl who has taken class work at the Brooklyn Botanic Garden not less than three seasons, and who has shown marked ability along botanical and agricultural lines, both at the Garden and in his high school course, as attested in writing by his principal and teachers. This prize will not be offered until 1920, and so this gives an opportunity for high school boys and girls this season to start at the Botanic Garden to work for this scholarship. It will be called the *Alfred T. White Scholarship.* This is a permanent prize and will be offered not only in 1920, but in 1921, and in all the years that follow after that. We trust that high school principals and biology teachers will bring this to the attention of their most promising students in the field of biology; and that elementary school principals will do the same in their seventh and eighth grades. Full details concerning the conditions of award will be published shortly. Application to enter for this scholarship should be made in writing to the Director, Brooklyn Botanic Garden.

ELLEN EDDY SHAW,
Curator of Elementary Instruction.

TEACHERS' NUMBER

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES VI BROOKLYN, N. Y., SEPTEMBER 25, 1918 NO. 6

CO-OPERATION OF THE BROOKLYN BOTANIC GARDEN WITH THE ELEMENTARY SCHOOLS

The work which the Brooklyn Botanic Garden has in mind to do in cöoperation with local schools may be divided into two distinct lines: first, the work with the teachers themselves; and secondly, the work with teachers and pupils together.

While not all of the work planned has been accomplished, at least a part of it has been inaugurated. It might be well to put in print again those things which are in our minds in regard to this work.

In presenting such a subject as nature study in city schools, certain great difficulties always will arise,as teachers well understand. Some of these difficulties can be best met, perhaps, through an institution like ours. So the Botanic Garden, to meet some such needs, has had in mind the preparation of what might be termed *nature study loan exhibits*. It has not been possible so far to prepare much of this loan material, although quite a little study material has been given to schools. Further information may be obtained from the writer.

Another line of work, already largely an accomplished fact, is that of lectures and practical courses for teachers in gardening and in nature study as it relates to gardens. Some such classes were started five years ago at the Botanic Garden—classes in fall greenhouse work, where emphasis was placed upon the raising of such bulbs as are easy to handle in class rooms; spring greenhouse classes, where vegetable and flower seedlings were raised for school and home gardens. Nature study classes, and short courses in gardening have also been given.

It was also planned to hold a series of grade conferences, taking up such topics laid down by the Board of Education in plant nature study as would be most easily handled in the average city classroom, studying such common material, and learning from it certain things about nature which the colleges, normal schools, and training schools often find no time to more than touch upon. For example, five or six lessons could be given for the fifth year, and so on for other grades. We have not been able so far to start this work because of the press of other pieces of work, which, while not more important, have been at least more urgent for the time being. Such work as this would represent extension courses which should count as credits for college work, or fit one for higher positions.

The work with teachers and children which has been already accomplished has been covered almost entirely by series of lessons and demonstrations which have been given each spring and fall. These, of course, were based upon the nature study lessons of the public schools of this city, and were intended to be helpful in such work. In many instances work started here was carried on in the classroom and reports sent to us. In some cases the work done here was used as a basis for assembly work. It has never been our intention to give any work here which did not relate directly to the school work. These classes of children and teachers have come in school time and have spent an entire half day at the Garden, not only getting acquainted with one of their city institutions, but at the same time carrying away with them definite help on some subject chosen by the teacher.

Below is given, grade by grade, the fall subjects (offered Oct. 7 to Nov. 8, 1918), which we have picked out largely from the nature study curriculum. We also have a special list for spring:

Grades 4A and 4B

1. Cultivation of plants by seeds, slips, runners, etc. (Greenhouse).
2. What plants need for growth. (Experiments).
3. Plant variations in the hot, cold, and temperate countries. (Lantern slides and specimen plants).
4. The cultivation of rice in China and Japan. (Lantern slides).
5. How boys and girls can help make Brooklyn a more beautiful city. (Lantern slides).

Grades 5A and 5B

6. How to plant bulbs for winter bloom. (Demonstration).
7. Plant foods raised in the United States. (Lantern slides).
8. How nature disperses her seeds. (Demonstration).
9. Useful plant products. (Lantern slides).
10. How to distinguish common evergreens. (Study of the trees themselves).

Grades 6A and 6B

11. The classroom window box. (Demonstration).
12. Coffee culture in South America. (Lantern slides).
13. How rubber is obtained. (Lantern slides).

Grades 7A and 7B

14. Plants for classrooms and care of same. (Demonstration).
15. Agricultural products of the United States. (Lantern slides).
16. What plants mean to the world's commerce. (Lantern slides).
17. The life of a tree. (Demonstration and slides).
18. Elementary Forestry.

This fall we are suggesting that the teachers or principals choose subjects that it might be impossible to take up at school, such as the recognition of common trees, fall wild flowers and weeds. In these talks material in limited quantity can be given to the classes to take back to their schools for further study. "Common garden vegetables" is another topic we would suggest, but only in those schools where the children have little chance to garden and so do not know much about vegetables. In schools where the children have gardens and feel that they are well acquainted with such material, it might be well if such a topic were given, from the standpoint of botany, taking up a little of the history of the vegetables and exactly what botanical part of the plant is edible.

Blank cards may be obtained from the Botanic Garden to be filled out and returned to us from the school telling exactly the topic the teacher would like to have given to the grade which is to be brought here. On this card there is a place to fill in any topic not on the list, which the principal or teacher or the members of the given class would like to have presented. We shall be very glad indeed if new topics be suggested, because in this way we may work out a more helpful and interesting set of lessons.

It has been in our minds to give out to the classes questions upon the lessons or demonstrations given, so that such questions may be a basis for the teachers' lessons after they return to their schools.

During the visits of all the grades from Public School 119, a year ago this fall, a rapid review of the lessons was given at the close of each period. Many of these same classes came for a second lesson, and at that time, different members of the class, either chosen beforehand or chosen at random, gave before their class a talk on the same subject that had been taken up before. If a given class could come more than once in a given season, the value of the work would be cumulative. This is a matter for the individual principal and teacher to decide, and for us only to recommend. It is, of course, not entirely valueless in education merely to visit an institution for an unrelated lesson, but it is far more valuable if the work given at such an institution becomes a part of the regular class work, or helps to emphasize some special feature of the schoolwork.

Another phase of our work with and for teachers, is the course in children's gardening. This course was primarily planned to be a help to teachers, not only in a new field of work, but as a part of their own school work. The course is of a year's duration, but may extend over more than one year, or may be taken altogether in one summer. All our courses include both theoretical and practical work, the latter taken up in the greenhouse and out of doors in the garden. The field of gardening has opened up more and more possibilities to teachers. The Brooklyn Botanic Garden has been used by a certain body of teachers, by about 25,000 children with their teachers every year, and by about 1,000 children or more who came for classes of from six weeks to six months' duration.

And finally to summarize our hopes and plans, most of which are already accomplished facts, for the work in elementary as well as more advanced education:

1. Our year's course for teachers of school gardening.
2. Our extension courses for teachers, such courses including not only the subject of gardening, but related subjects like nature study and special features of that, such as tree work.
3. Our summer school of gardening which differs from the course for teachers of gardening in that such work is given in a shorter period during the summer vacation. Any season the work may emphasize a special need in garden work, as it did this summer when the theme of the school was: "High School Botany and its Relation to School Gardens."
4. Work given in the form of lectures, lessons, and demonstrations in gardening and nature study to supplement the work of the elementary schools, and the work given in school time to visiting schools with their teachers.
5. Loan and study material.
6. Work with children in greenhouse classes and the outdoor garden, classes made up independent of the schools and not in school time.
7. Work of Boys' and Girls' Clubs representing special study on special topics.
8. Work with the High Schools to supplement the work of high school botany and to do such work as is difficult to do except under such surroundings as those at the Botanic Garden. This work is done both in school time and out of school time, both with and without the high school teacher.
9. Exchange courses and lectures at other institutions.
10. Work given at the Public Schools. This takes the form of demonstrations, assembly work, and work at teachers' meetings.

ELLEN EDDY SHAW.

TEACHERS' NUMBER

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

SERIES VI BROOKLYN, N. Y., OCTOBER 9, 1918 NO. 7

CHILDREN'S GARDEN WORK PLUS THE DOLLAR SIGN—HOW THE WAR EFFECTS CHILDREN'S GARDENING

Because of the war, plans have changed very much for the development of the children's garden work at the Brooklyn Botanic Garden. Perhaps it would be more accurate to say that these original plans have been almost entirely set aside, and our energy and time have been expended in what might be called war-garden work.

Sometimes it is well to put in writing the ideals for a piece of work, although these ideals may not be realized for a number of years. Some five years ago, the Department of Elementary Instruction outlined a program which seemed permanent and worth while. One side of the work was to be an outdoor garden for boys and girls. This garden was not to be of the type of the ordinary garden—one found on vacant lots and in city parks, where the main object must be, by necessity, that of using space for as many children as possible. This was not our idea at all. Such gardens have been started and carried on successfully under various methods and different associations for years; but no botanic garden in this country, up to the time the Brooklyn Garden was started, had inaugurated a popular educational side of its work on so extensive a scale as that contemplated by the Brooklyn Garden, including children's gardens, greenhouse classes for children, and certain other new features.

Then what was our aim and purpose for this boys' and girls' garden? There was to be an area set aside for young people to come to and learn how, not only to raise beets and cabbages, but to raise flowers as well—to know the common shrub, to acquaint themselves with different plants growing under different conditions, to realize by actual experimentation and work that plants belong in families, and that family traits are persistent. So the idea spread itself out over the field of botany in such a way that children should acquire some idea of the everyday side of botany in its application to gardens and different conditions of planting.

After five years of work, one would expect to see here a neat and trim vegetable garden and flower gardens of annuals and perennials, a bit of lawn, a rose garden, a garden of wild flowers, a spot set aside for plant families, and common shrubs and vines—and yet all this is not to be seen here. Instead, one sees all the boys' and girls' area put to vegetable gardens, of different sizes, and laid out with different aims in view. This is our special war work, to use every foot of space, not only for a broader education and a wider outlook, but to raise as much crop as possible as long as the war lasts. But even in this common everyday sort of limited gardening, if one has the eyes to see, there are features which set this garden a little apart from the ordinary war garden.

Perhaps the feature that is best worth noting, and least likely to be noted, is that the garden is planned on the educational principle of progression. To illustrate this concretely, let us suppose that a high school boy, a child of twelve, and another of eight, enter this garden at the same time. None of them has ever had any definite instructions in gardening before, so, regardless of age, they are all started at one and the same place; that is, they are given small plots of land 8 by 10 feet. They are all given the same initial lessons. These lessons take up the preparation of gardens for planting, the measuring off of drills for seed, methods of planting different kinds of seeds so that the resultant crops will be typical of different methods of treatment. There are certain underlying principles of gardening and of planting and of crop handling which are essential to have at the outset, just as it is essential for a child to be grounded in the first elements of his regular school subjects. One usually starts a child in kindergarten or the first grade, rather than start him in the sixth or seventh grade of school. This is for obvious reasons. In the same way our garden lessons should be planned with the same ideas and principles in sight.

Even though we are all working at the present time on what we term war gardens, at the same time we should be doing war work which will last. People should not forget that gardening for children is not primarily a matter of economic value; that is, of dollars and cents, but is a matter of pedagogy, physiology, and child study. An illustration of the truth of this came to me forcibly through a little story told of a farmer who had some high school boys working for him and was unable to get any work out of them. If the farmer had been less a farmer, and more a student of human nature, he could have turned the coltish pranks of the boys into serious and productive labor. Obviously if gardening is not one of those educational subjects from which and through which we are to make better citizens, then school gardens are a waste of time except during the period of war, and those of us who have worked a good share of our lives in this field know that gardening is of lasting value to children only when the lessons extend beyond the dollar sign.

But since the viewpoint of the dollar is, unfortunately, of greater carrying weight than the viewpoint of development in citizenship, the argument of the dollar is often the only one considered. Good crops are always the natural results of good lessons taught in gardening, and it is unfortunate, even as a war measure, to try to obtain results founded on poor methods.

So it was that we started our war gardens, twisting the economic value around the educational core that is intended to be the basis of our work at the Brooklyn Botanic Garden.

To go back to the example of our high school boy, the child, and the youngster of eight. After the first lessons have been digested and put into practice, after the work of transplanting, thinning and cultivating have been rubbed into these beginners, they naturally go at different rates of speed. As fast as the lessons are mastered, they go on to different phases of vegetable culture. It usually happens that the first year these three, while going at a little different rate of progress, will, after all, stay about together, doing the same work with differing degrees of excellence; but after this first season the high school or older boy or girl is ready to go onto a larger area of land, trying out the same lessons, either using much the same crops, or else specializing on some crop which is far more difficult to raise.

This means that he must start his garden work in January or February, instead of April or May. This means that he must come to the greenhouse, start his egg-plant, tomatoes, or peppers, that he must sit down and draw his plan and submit that for approval. The longer that boys and girls work at vegetable gardening, the more independent they desire to be, and no garden which is not based upon individual progress can go very far educationally.

It would have been of the greatest interest to educators to have seen a group of fifty or more high school and upper grade boys and girls making their plans for their war gardens last spring. Each was given a piece of land 10 by 20 feet, and each could plant what he or she desired for the needs of the different families represented. No two gardens were alike. Some of those boys and girls found themselves at mid-season tied up with serious problems of pests because they had no chosen crops which lend themselves easily to insect or fungus depredations. This is another phase of work which is representative of an advanced stage in garden practice.

The usual method of discovering a cabbage worm and then inviting the one hundred or more children in the garden to come and look at it, does not carry very far; but when a lad finds a pest in his own garden, takes his books, or goes to a library and makes it his business to study that out independent of instruction, and then posts up his simple research work upon the bulletin board, or goes about through the garden explaining to his companions what he has found, what harm it does, and how he can get rid of it—this sort of work represents thought, independence of action, and ability to spread knowledge.

As seasons of work go on, some of our older gardeners hand in requests for larger areas for special purposes, such as the growing of corn, peas, winter beans, etc. Corn is not a crop which is raised in small areas, and so it is saved for special work, because it requires special attention. One of the problems has been to try out different varieties of corn in different years to find out the best seed for our special conditions of soil and climate. The ravages of corn worms, the picking of corn when it is exacty right to be picked, methods of crossing, the tying up the corn in shocks—these are not pieces of work for eight-year-old children, any more than partial payment and cube root are arithmetical lessons for the second or third grade.

Various plans have been tried out in the general layout of the gardens. For instance, one season several boys and girls worked together, combining a number of gardens into one, thus wasting no space in cross paths. They planned together, measured and strung long cords of lines through this area. The general effect was that of a young market garden. Each boy or girl had his own special number of feet in this section. It was only a matter of co-operative working in the first preparation and planning.

Others have devoted themselves to potato problems, using different methods of cutting, and keeping records of the crops resulting from such plantings.

The last step in garden lessons is that of individual original work, either on some crop, or using a piece of land for a special purpose, to wring out of the land all that is in it. For instance, a problem still unsolved is this: can a certain area of land, using the same crops as the younger children use, be worked by a boy so that he may take a much larger crop from it than any of the first year children could possibly take? We have worked on this for some time, and during this last season one boy doubled the amount of crops taken from a garden of the same area as that worked by a first year boy or girl. Thus the financial end of gardening is only another step in progress.

The flower borders, still kept even in war times because we love them, and because they are used for hospitals, homes, and mother's and father's birthday bouquets, represent co-operative work. Many of the plants are started in the greenhouse and planted out so that the first bloom comes in late June or early July, and, by careful setting of annuals in and about these greenhouse seedlings, continuous bloom is obtained all through the season. This is a problem which opens up all sorts of interesting sides never to be entirely solved and worked out, always varying, always offering opportunity for thought, book work and greenhouse practice. Nothing tends more to the holding of boys and girls to a task than this idea of progressive educational work.

There is another essential aid to permanent interest, and that is the financial side of the garden. This is a far more difficult problem in the regular school garden, but it seems only ethical that a boy or girl should pay for his piece of land a price which in some measure covers at least the cost of seed. There is a great incentive to raise a splendid crop if you have invested a sum of money in this experiment. "Can you make one hundred or two hundred per cent on your garden investment?" is a question we often put up to our boys and girls. Given a garden 8 by 10 feet, the price for which is twenty-five cents, what can you make? Given a garden 10 by 20 feet for fifty cents, what can you make on this investment? There is very little danger of a boy losing interest in what he has put cash into. We suppose if a child paid for his arithmetic lessons there would be a quickening interest in arithmetic. This was clearly demonstrated in former days, when the farmer's son, having no free high school to attend, had to work out his tuition in the village school.

This last season we have had in our garden a small group of Italian boys from a certain club. The club paid the fees for the boys, against the advice of the Botanic Garden. All these boys dropped out of their work, saying, when they were told that they were losing the money that had been put into the garden, they did not care because it was not their money. In a garden of 387 boys and girls, those nine were the only ones who dropped out from lack of interest; therefore, the lack of interest could not be laid to the teaching. In our opinion, it went back entirely to the fact that these boys did not have to raise their own money—they had made no investment.

Connected with this garden is a summer school for adults. The garden is supposed to be a practical school for those who wish to take up, as a profession, children's garden work. The summer school has failed to have the practice that it might have had could we have accomplished our first vision for this garden, but perhaps the students have received more in other ways. The members of this summer school have their lessons as the children have them: they plant their own gardens, care for them, make a study of those things in nature which apply to and touch the garden, such as shade trees, wild flowers, the weeds that bother us, the insects that prey upon our crops, the tools we use, the baskets we carry as containers—all those things which are correlated phases of this work. We give some time, during this summer school, to the discussion of high school botany as it might be worked out through the school garden. The future of botany, at least in our secondary schools, is dependent upon those practical applications which teachers are able to make, just as garden work and nature study in the elementary school lives when it becomes vital and affects the individual.

Ellen Eddy Shaw.

BROOKLYN BOTANIC GARDEN

LEAFLETS

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES

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FERTILIZERS FOR CITY GARDENS*

It is generally admitted that stable or barnyard manure is the best all-round fertilizer for the garden. It contains nitrogen, phosphorus, and potash, the three most important elements necessary to supply in order to maintain the soil in a state of fertility. Manure usually gives satisfactory results even though no other fertilizers are used. In addition to the plant food contained, it supplies humus (decayed organic matter) which improves the physical properties of the land and by its decay makes plant foods available that would otherwise be locked up in the soil. Experience has shown that in order to get the best results from the use of "commercial" fertilizers it is necessary for the soil to be well stocked with humus, and stable or barnyard manure is probably the best form in which this can be added to the soil. Barnyard manure may be applied in the spring or fall. If applied in the fall fresh manure may be used, first spreading it over the surface and then digging the plot so as to bury the manure as deeply as possible. If application is deferred until the spring it should be partly decayed, as in this form the plant foods it contains are more quickly available for the use of the crop. If the manure is thoroughly decayed and in a finely pulverized condition it is a good plan to first dig the ground, leaving the surface rough, and then spread the manure, afterwards raking thoroughly so as to mix it with the surface soil. The quantity to use depends upon the amount of humus already present in the soil and whether it is planned to use commercial fertilizers in addition. If the soil is deficient in humus a heavy application is desirable to improve its physical condition; on the other hand, if humus is already present in large quantities, it will be economical to reduce the amount of stable manure and supply the chemical elements necessary by using more concentrated ferti-

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lizers. Commercial vegetable growers use anywhere from 10-100 tons of manure per acre, the amount generally used being 20-30 tons. For the small garden from 300 to 500 pounds for a plot containing 400 square feet, or spread on the surface from one to three inches thick will be suitable. If manured in the fall in this manner a dressing of 6-8 pounds of "complete" commercial fertilizer analysing about 4% nitrogen, 8% phosphoric acid, and 8% potash, obtainable from most seedsmen, could be applied to advantage in the spring (though not absolutely necessary) as a surface dressing; raking it in so as to mix it thoroughly with the top soil. If the commercial fertilizer is deficient in potash, as is generally the case at the present time, the lack can be made up by the addition of 10-20 pounds of unleached hardwood ashes.

It often happens that it is not convenient in city gardens to maintain the supply of humus by the use of barnyard or stable manure. In these circumstances the growing of a cover crop* to provide green manure is a convenient method of supplying humus. Another source of supply open to city dwellers is the collection of the leaves of street trees when they drop in the autumn. These should be piled in an out-of-the-way corner of the garden and mixed with the soil when they are one or two years old. Decay may be hastened by forking over the leaves two or three times during the summer. Garden refuse of all kinds, such as lawn clippings, the leaves and stems of vegetables and flowers, may be treated in the same way. This latter method sometimes has the disadvantage of returning to the soil the spores of disease organisms that may be present, thus providing a source of infection for future crops.

When humus is supplied in the form of green manures or leaves the amount of "complete" commercial fertilizer used should be greater—from 12-18 pounds, analysing 4% nitrogen, 8% phosphoric acid, and 8% potash to 400 square feet.

Chicken manure, which is sometimes available, is one of the most concentrated of the organic fertilizers. It can be used to good advantage to supplement a dressing of barnyard manure, at the rate of 20 pounds to 400 square feet. As the plant foods it contains are quickly available, it should be applied in the spring as a surface dressing, thoroughly mixing it with the soil. If this fertilizer is available in a sufficient quantity to warrant its being used as a base for a complete fertilizer it should be used at the rate of 40-50 pounds to 400 square feet, supplemented by 6-8 pounds of acid phosphate and 6-8 pounds of unleached hardwood ashes. The chicken manure must not be mixed with the other ingredients before application, or loss of nitrogen will result. Chicken manure, previous to use, should always be stored under cover to prevent leaching. A good method, which facilitates future handling, is to place it in barrels or boxes in layers with an equal amount of dry soil.

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*See Brooklyn Botanic Garden LEAFLETS Ser.V. No. 11.

Sheep manure, while not so concentrated as the preceding, can be used in much the same way by increasing the quantity about 50%.

Bone meal is an important source of phosphoric acid; also contains some nitrogen. The coarser grades are rather slow acting and the food materials contained are not immediately available. It is used at the rate of 12 pounds to 400 square feet. Acid phosphate, prepared from phosphatic rock, is another important fertilizer supplying phosphorus. It is used at the rate of 6-8 pounds to 400 square feet.

Wood ashes contain potash and lime and small amounts of phosphoric acid. It is a fertilizer especially valuable on clayey soils, as it improves their physical condition. It is considered to be a valuable fertilizer for all fruits—apples, peaches, etc.—and for crops that are grown for their roots, such as beets and carrots. Use 20 pounds to 400 square feet.

Sulphate of potash, muriate of potash, and kainit contain potash in a more concentrated form than the preceding, but these are scarce and practically unobtainable at present.

Nitrate of soda is a very quick-acting fertilizer and is useful for stimulating the growth of plants in early spring when the nitrogen content of the soil is usually low. It is especially valuable for crops that are grown for their leaves, such as cabbage, Swiss chard, spinach, and lettuce. Use 1½ to 2 pounds to 400 square feet. As nitrate of soda is readily soluble in water, it should not be applied much before planting time or it will leach out of the soil before the crop can use it. The writer prefers to use this fertilizer as a top-dressing after the plants have started their growth, applying it at the rate of ½ ounce to a square yard at intervals of about three weeks. All lumps must be crushed before using and care must be taken not to allow any to lodge on the leaves of the crop. Great caution must be exercised in the use of this fertilizer, especially in connection with crops that are grown for their roots or fruits, such as beets, carrots, peas, beans, and tomatoes, as it may result in the production of leaves at the expense of the part desired for use. Sulphate of ammonia and dried blood are other important sources of nitrogen.

Acid phosphate, bone meal, nitrate of soda, and wood ashes are not what are known as "complete" fertilizers. That is, they do not provide nitrogen, phosphorus, and potash. It is customary to use them in combination with other fertilizers or to supplement a complete organic fertilizer which may have a deficiency of one or more of the three elements most necessary as plant foods. It will be noticed, for instance, that wood ashes is part of the formula with chicken manure as a base. Bone-meal could be used to take the place of the acid phosphate in this formula.

Lime is an indirect fertilizer in that it helps to put the soil in good physical condition, provides the slight alkalinity desirable for most vegetable crops. and assists in making inert plant foods available. It is used in the form of ground limestone, or air-slaked lime, at the rate of 20 lbs. to 400 square feet.

It should be borne in mind that lime, or any fertilizer containing lime, such as wood ashes, must not be applied so as to come in contact with any organic manure or it will result in loss of nitrogen.

All concentrated fertilizers can be best applied by first digging or plowing the ground leaving the surface rough, then scattering the fertilizer, afterwards raking to mix with the soil. Bulky manures, such as undecayed barnyard or stable manures, leaves, and cover crops should be dug in as deeply as possible.

MONTAGUE FREE.

NOTICES

The Garden is open free to the public daily, from 8 a. m. until sunset; on Sundays and holidays at 10 a. m. The Laboratory Building, containing the library, herbarium, and offices, is open daily, from 9 a. m. until 5 p. m. The Conservatories are open April 1–October 1, 10 a. m.–4:30 p. m.; October 1–April 1, 10 a. m.–4 p. m.

The Garden may be reached by Flatbush Ave. trolley to Malbone St.; Franklin Ave., Lorimer St., and Tompkins Ave. trolleys to Washington Ave.; St. John's Place and Rogers Ave. trolleys to Sterling Place; Vanderbilt Ave., Sixteenth Ave., Union St., Greenpoint, and Smith St. trolleys to Prospect Park Plaza and Union St., and Brighton Beach elevated to Consumers' Park Station. (The elevated trains stop only when the conductor is notified in advance.)

A docent will meet parties by appointment and conduct them through the Garden. This service is free to members of the Botanic Garden and to teachers with classes; to others there is a nominal charge of 25 cents an hour for parties of less than three, and 10 cents a person per hour for parties of three or more.

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